U.S. Army Center for Health Promotion and Preventive Medicine

THE ABERDEEN PROVING GROUND INJURY CONTROL PROJECT: INFLUENCE OF A MULTIPLE INTERVENTION PROGRAM ON INJURIES AND FITNESS AMONG ORDNANCE SCHOOL SOLDIERS IN ADVANCED INDIVIDUAL TRAINING

USACHPPM PROJECT NO. 12-HF-7990-03

US Army Center for Health Promotion and Preventive Medicine
Aberdeen Proving Ground, MD

Kirk Army Health Clinic
Aberdeen Proving Ground, MD

US Army Ordnance Center and School
Aberdeen Proving Ground, MD

US Army Physical Fitness School
Ft Benning, GA

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Readiness Thru Health

U.S. Army Center for Health Promotion and Preventive Medicine

The lineage of the U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM) can be traced back over 50 years. This organization began as the U.S. Army Industrial Hygiene Laboratory, established during the industrial buildup for World War II, under the direct supervision of the Army Surgeon General. Its original location was at the Johns Hopkins School of Hygiene and Public Health. Its mission was to conduct occupational health surveys and investigations within the Department of Defense's (DOD's) industrial production base. It was staffed with three personnel and had a limited annual operating budget of three thousand dollars.

Most recently, it became internationally known as the U.S. Army Environmental Hygiene Agency (AEHA). Its mission expanded to support worldwide preventive medicine programs of the Army, DOD, and other Federal agencies as directed by the Army Medical Command or the Office of The Surgeon General, through consultations, support services, investigations, on-site visits, and training.

On 1 August 1994, AEHA was redesignated the U.S. Army Center for Health Promotion and Preventive Medicine with a provisional status and a commanding general officer. On 1 October 1995, the nonprovisional status was approved with a mission of providing preventive medicine and health promotion leadership, direction, and services for America's Army.

The organization's quest has always been one of excellence and the provision of quality service. Today, its goal is to be an established world-class center of excellence for achieving and maintaining a fit, healthy, and ready force. To achieve that end, the CHPPM holds firmly to its values which are steeped in rich military heritage:

★ *Integrity is the foundation*
★ *Excellence is the standard*
★ *Customer satisfaction is the focus*
★ *Its people are the most valued resource*
★ *Continuous quality improvement is the pathway*

This organization stands on the threshold of even greater challenges and responsibilities. It has been reorganized and reengineered to support the Army of the future. The CHPPM now has three direct support activities located in Fort Meade, Maryland; Fort McPherson, Georgia; and Fitzsimons Army Medical Center, Aurora, Colorado; to provide responsive regional health promotion and preventive medicine support across the U.S. There are also two CHPPM overseas commands in Landstuhl, Germany and Camp Zama, Japan who contribute to the success of CHPPM's increasing global mission. As CHPPM moves into the 21st Century, new programs relating to fitness, health promotion, wellness, and disease surveillance are being added. As always, CHPPM stands firm in its commitment to Army readiness. It is an organization proud of its fine history, yet equally excited about its challenging future.

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13. ABSTRACT *(Maximum 200 words)*

The injury and fitness outcomes were examined before and during a multiple intervention program designed to reduce injuries among Ordnance student in Advanced Individual Training (AIT). A historical control (HC) group comprised of AIT soldiers at APG 18 months before the program was compared to an injury management (IM) group comprised of AIT soldiers attending school for 8 months after the injury-control interventions were put in place. There were three interventions including 1) modification of physical training, 2) cadre injury education, and 3) a Battalion Surveillance System. As a result of the educational program, the command group instituted an Injury Control Advisory Committee that discussed possible strategies to reduce injuries. AIT soldiers completed a questionnaire on demographics and lifestyle characteristics. The Ordnance School Department of Academic Affairs provided administrative data on the soldiers. Injury data was obtained from a clinic-based surveillance system. Fitness data was obtained from the Army Physical Fitness Test (APFT, push-ups, sit-up and 2-mile run). Cox regression (survival analysis) was used to examine differences in time to the first injury while controlling for HC and IM group differences in terms of demographics, lifestyle characteristics, administrative measures, and physical fitness. The adjusted relative risk of a time-loss injury was 46% higher in the HC men and 58% higher in the HC women compared to the IM men and women, respectively. More men in the HC group passed the initial APFT compared to men in the IM group. However, IM and HC men did not differ on the proportion passing the first final APFT or passing after all final APFTs had been completed. For the women, there were no group differences on the initial APFT, first final APFT, or after all final APFTs were completed. After correcting for the lower initial fitness of the IM group, there were no significant raw score differences between IM and HC groups on any of the three APFT events for either gender. This multiple intervention program was successful in reducing injuries while maintaining improvements in physical fitness necessary to pass the APFT.

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Table of Contents

Executive Summary

The Aberdeen Proving Ground Injury Control Project:
Influence of a Multiple Intervention Program on Injuries and Fitness
Among Ordnance School Soldiers in Advanced Individual Training
USACHPPM Project Number 12-HF-7990-03

1. INTRODUCTION: As a result of ongoing injury surveillance at Aberdeen Proving Ground (APG), the U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM) recommended to the 61st Ordnance Brigade Commander specific injury control interventions for Ordnance School Advanced Individual Training (AIT) soldiers. These interventions included modifications to the physical training program, injury-awareness education for the drill sergeants and command group, and introduction of a unit-based injury surveillance system. The Brigade Commander approved implementation of these suggestions in March 2001. This paper presents the injury and fitness outcomes associated with these interventions.

2. METHODS. Soldiers attending AIT at APG train to qualify for one of five different Military Occupational Specialties (MOS) all of which involve vehicle repair and maintenance. Two cohorts of these soldiers were compared to determine the effectiveness of the injury control program. One cohort was called the historical control (HC) group and was comprised of soldiers attending AIT from 24 January 2000 to 20 July 2001. The other cohort was called the injury management (IM) group and was comprised of soldiers attending AIT between 23 July 2001 and 29 March 2002 (after the injury-control measures were in place). Soldiers who overlapped the time periods for both groups were not considered in the analysis. Both cohorts were part of the 143rd Ordnance Battalion (3 companies) at the Edgewood area of APG.

a. IM group injury control interventions were as follows.

(1) Physical Readiness Training (PRT). PRT is the Army's emerging physical fitness doctrine. Trainers from the US Army Physical Fitness School provided drill sergeants a 36-hour block of instruction on PRT exercises. PRT for AIT ordnance school soldiers was organized such that calisthenic exercises were performed first followed by guerilla drills. On alternate days either climbing drills or dumbbell drills were performed. Interval training was performed one to two times each week and long-slow sustained ability group runs were performed about once a week (no more than 2 miles/run). Soldiers trained 5 days a week. Soldiers who entered the unit after PRT began were given a week to learn the exercises and adapt to them. Training was monitored and deviations corrected.

(2) Battalion Surveillance System. This system was placed on each company's computer just prior to the start of the IM period. The system consisted of a Microsoft Access relational database that was linked to the

personnel roster database. When an injured soldier returned from the troop medical clinic, data from the modified limited-duty profile form provided by the medical providers was entered into this system. Training cadre or the command group could generate 18 real-time reports. This surveillance and reporting system was designed to enable the leadership to benchmark their injury rates, ascertain the causes or sources of injuries, and monitor the effectiveness of changes they made to reduce injuries.

(3) Education Program. USACHPPM provided an 8-hour block of instruction on injury control techniques to the AIT drill sergeants and command group. Training involved a discussion of overuse injuries, causes of injuries at APG, risk management techniques, sports and exercise-related injury associations, relationships of work tasks and equipment with injuries, factors contributing to injuries, development of an Injury Control Advisory Committee, and a final exercise applying the risk management process to specific injury problems. The battalion developed an Injury Control Advisory Committee that met seven times during the eight-month IM portion of the project.

b. Data Collected. Soldiers completed a questionnaire on arrival at APG that asked them about demographics and lifestyle characteristics. The Department of Academic Affairs at APG provided administrative data (MOS, component, date of arrival, and date of departure from APG). Injury data was obtained from a surveillance system that recorded all AIT soldiers' sick call visits to the Troop Medical Clinic. Fitness data was obtained from the Army Physical Fitness Test (APFT) consisting of the maximum number of push-ups and sit-ups completed in separate 2-minute periods and a 2-mile run for time. Test values were obtained from the first diagnostic test administration (within the first week of AIT) and from the final record test administration (in the eighth week of training.)

3. RESULTS.

a. Injuries. Cox regression (survival analysis) was used to examine differences in time to the first injury while adjusting for differences between groups in terms of demographics, lifestyle characteristics, administrative measures, and physical fitness. The adjusted relative risk (ARR) of a time-loss injury (an injury for which a limitation of duty was prescribed by the health care provider) of any type was 46% higher in the HC men and 58% higher in the HC women compared to the IM men and women. For time-loss overuse injuries, the ARR of injury was 55% higher in the HC men and 148% higher in the HC women, compared to the IM men and women. For time-loss traumatic injury, the ARR of injury was 51% higher in the HC men relative to the IM men. Although the ARR of a time-loss traumatic injury was 33% higher in the HC women relative to the IM women, this did not reach statistical significance.

b. Fitness. More men in the HC group passed the initial APFT compared to men in the IM group. However, the IM and HC men did not differ on the

proportion passing the first final APFT or passing after all final APFTs had been completed. For the women, there were no group differences on the initial APFT, first final APFT, or after all final APFTs were completed. After correcting for the lower initial fitness of the IM group, there were no significant differences between IM and HC groups in APFT raw scores on the three APFT events.

4. DISCUSSION.

a. This study used what has been termed in the literature a "community based injury reduction approach". This approach combines aspects of educational efforts with focused community leadership participation, multi-agency collaboration, modification of attitudes, behaviors and norms, and alterations in the physical environment. Past investigations have shown this multifactoral approach to be successful in reducing injuries but the approach does not allow determination of the most effective single strategies.

b. As a result of the educational program, the command group instituted an Injury Control Advisory Committee. This committee was comprised of all three training company commanders, their senior drill sergeants; the Battalion Plans, Operations, and Training Officer; and an injury subject matter expert from the local medical department. The intent of the committee was to review surveillance reports from the Battalion Surveillance System, discuss strategies to reduce injuries, and to monitor the effectiveness of changes. In reality, the committee recommended very few changes. Most meeting time was spent in sharing reports and examining the distribution and source of injuries. This left little time to discuss trends and perform problem solving.

c. Certain features of the PRT program may account for a portion of the reduction in injuries. These features included the gradual introduction of the exercises following the principle of progressive overload, a reduction in running mileage, and the use of cross training.

5. LIMITATIONS. Historical cohort studies can be strongly influenced by temporal changes that are not apparent and cannot be readily identified such as changes in training cadre, changes in physical training procedures in HC cohort, and differences in criteria for assigning limited-duty profiles. Remedial physical training, not originally planned for the study, was instituted when the IM portion of the project was about 40% complete; the HC group also had a remedial group.

6. CONCLUSIONS. The multiple intervention program used in this project included the introduction of PRT, cadre injury-reduction education, and use of a unit-level surveillance system. It was found that soldiers who were present during the intervention period had lower injury risk and similar improvements in physical fitness when compared to soldiers who were present prior to the intervention period. This multiple intervention program was successful in reducing injuries while maintaining necessary improvements in physical fitness.

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The Aberdeen Proving Ground Injury Control Project: Influence of a Multiple Intervention Program on Injuries and Fitness Among Ordnance School Soldiers in Advanced Individual Training USACHPPM Project Number 12-HF- 7990-03

1. REFERENCES. Appendix A contains the references used in this report.

2. INTRODUCTION.

a. Injuries have become an item of increasing interest in the US military as the magnitude of the injury problem has become apparent. About half of all deaths, half of all disabilities and half of all outpatient medical visits are accounted for by injuries. Injuries result in 5 to 22 times more days of limited duty than do illnesses (39, 56). Specific interventions have been tested and shown to be successful in controlling injuries in military environments (2, 48, 52, 57, 59, 80, 86). These intervention studies show that the high injury rate in the military is not an inevitable consequence of training and operations.

b. From August to December 1999, U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM) worked with Kirk Army Health Clinic (KAHC) at Aberdeen Proving Ground (APG) Maryland, to develop an injury and illness surveillance system. This system captured the sick call visits of Ordnance School Advanced Individual Training (AIT) students to the Acute Care clinics at two sites at APG where medical care was provided (Aberdeen and Edgewood). From December 1999 to April 2000, USACHPPM and KAHC worked with the Ordnance Center and School to find the most effective methods of presenting injury and illness surveillance data to commanders. Routine injury and illness surveillance reports were provided to company and battalion level commanders in the two AIT Ordnance Battalions (16th and 143rd Ordnance Battalions of the 61st Ordnance Brigade) at APG beginning in January 2000 and continuing to the present day.

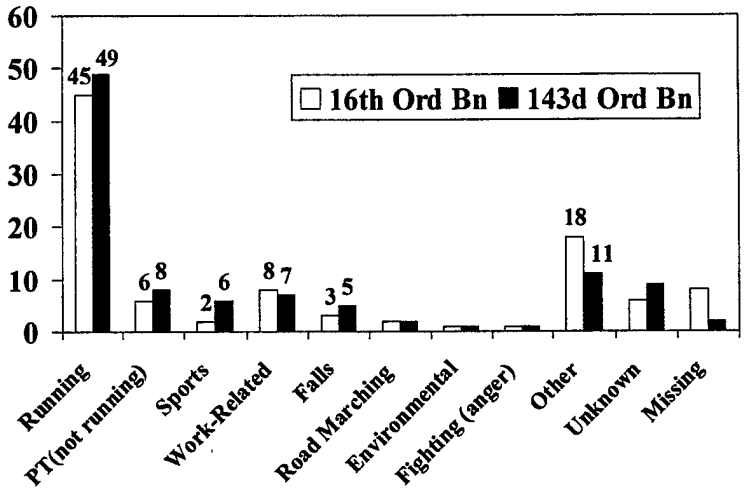
c. The surveillance system collected specific data in separate injury and illness databases. The injury database contained causes of injuries, anatomical locations, types of injuries, dispositions, and days of limited duty. The illness database contained the diagnosis, disposition, and days of limited duty. Analysis of the data from January to December 2000 showed that 53% to 63% of injuries appeared to be associated with sports and exercise activity as shown in Figure 1.

d. In March 2001, these data were briefed to the 61st Ordnance Brigade Commander with recommendations for injury control measures. Specifically, modifications in the physical training program and education of the cadre on injury control techniques were recommended. The commander accepted these

recommendations and the USACHPPM assumed responsibility for developing the programs. The U.S. Army Physical Fitness School (USAPFS) was contacted and agreed to train the cadre at the 143rd Ordnance on Physical Readiness Training (PRT) techniques (53). The USACHPPM developed the injury education curriculum. Just prior to the start of the injury control measures, a unit-based injury surveillance system was developed and installed on the computer of each company in the 143rd Ordnance Battalion.

e. This paper presents the outcome of a multiple intervention program designed to reduce injuries among Ordnance AIT soldiers.

Figure 1. Activities Associated with Injuries
Among Ordnance School Students
(From the APG Surveillance System, January-December 2000)



3. BACKGROUND LITERATURE.

a. Injury Risk Factors.

(1) Extensive work has been performed to identify risk factors for injuries in Basic Combat Training (BCT); however, the literature on injury risk factors during AIT is sparse. Injury risk factors can be identified as those that are extrinsic or intrinsic. Extrinsic risk factors are those related to the environment. Intrinsic risk factors are those due to personal characteristics of the individual soldier.

(2) Extrinsic risk factors that have been identified in BCT include higher running mileage, older running shoes, and the summer season. There are large differences in injury rates among training companies (12, 38, 62) and these differences appear to be associated, at least in part, with differences in running

mileage (38, 87, 96). Longer road marching distance may also be associated with injuries but the data are conflicting (53, 96). Older running shoes are associated with a higher risk of stress fractures (21). Seasonal variations in injury rates appear to occur in BCT with higher overall rates in the summer and lower rates in the fall (47).

(3) Intrinsic risk factors identified in BCT include female gender (7, 35, 36, 38, 50, 66), high foot arches (14, 27), knee Q-angle >15° (13), genu valgum (13), past ankle sprains (38), low aerobic fitness (31, 35, 36, 50, 62, 63, 75, 97), low muscular endurance (38, 63), high and low extremes of flexibility (38, 41, 62, 63), low levels of physical activity prior to BCT (21, 31, 35, 36, 38, 62, 63), cigarette smoking prior to BCT (31, 38, 60, 62, 63), and older age (31, 38). Less consistently demonstrated intrinsic risk factors include lower levels of muscular strength, higher body fat or body mass index, and white ethnicity (6, 8, 21, 31, 35, 36, 38, 50, 60, 62, 63, 97). Multivariate analysis have consistently shown that cigarette smoking prior to BCT, low levels of aerobic fitness, and low levels of physical activity prior to BCT are independent injury risk factors (31, 38, 44, 63, 73).

(4) In contrast to the extensive work done on injuries in BCT, the literature on risk factors in AIT is limited to one study. Henderson et al. (32) examined a cohort of men and women attending the 10-week US Army Combat Medic course at Fort Sam Houston, Texas. Injury incidence during the training was 24% for men and 26% for women. Potential risk factors examined in this study included age, stature, body mass, body mass index (BMI), race, split option (a break in service between BCT and AIT), injury in BCT, cigarette use, alcohol use, and physical activity prior to enlisting. None of these variables emerged as risk factors for the men. For the women, older age (>25 years), split option, and greater body mass were independent injury risk factors.

(5) It should be noted that it is important to identify and quantify risk factors for injuries in cohort studies. This is because if risk factors are unevenly distributed between groups, differences in injury rates may be due to this distribution and not the interventions of interest. Thus, efforts were made in this study to include risk factors previously identified in past investigations.

b. Modifications to Physical Training.

(1) Only two studies have systematically examined modifications to physical training during Initial Entry Training. One study involved BCT soldiers and the other involved medic AIT soldiers.

(2) The first investigation (53, 54) examined fitness and injury outcomes during the initial "toughening phase" of the US Army's emerging physical fitness doctrine which is called Physical Readiness Training (PRT). A BCT battalion implementing PRT (Experimental battalion, n=1284) was

survival analysis and controlled for initial group differences in demographics, fitness, and training-related variables. The relative risk of an injury of any type was 37% higher in the Control men ($p=0.02$) and 35% higher in the Control women ($p<0.01$), compared to the Experimental men and women. The relative risk of an overuse injury was 57% higher in the Control men ($p<0.01$) and 45% higher in the Control women ($p<0.01$), compared to the Experimental men and women. There were no differences between the Experimental and Control groups for traumatic injuries ($p=0.84$ and $p=0.70$ for men and women, respectively). On the first administration of the Army Physical Fitness Test (APFT) taken for record, the Experimental group had a greater proportion of trainees who passed than the Control Group (men: 85% vs. 81%, $p=0.04$; women: 80% vs. 70%, $p<0.01$). After all administrations of the record APFT, the Experimental group had fewer APFT failures than the Control group among the women (1.6% vs. 4.6%, $p<0.01$) but not the men (1.6% vs. 2.8%, $p=0.18$). On push-up raw scores, Control men and women improved more than the VF men ($p<0.01$) and women ($p<0.01$), although the VF group scores exceeded minimum BCT passing values. On sit-up raw scores there were no differences between the VF and Control men ($p=0.21$) but the VF women improved more than the Control women ($p<0.01$). There were no differences in improvements in 2-mile run times between the VF and Control men ($p=0.15$) or women ($p=0.54$). The PRT Program reduced overuse injuries while allowing a higher success rate on the APFT.

(3) Another investigation examined injuries and fitness among soldiers utilizing different training methods while attending the 10-week medic AIT at Fort Sam Houston Texas. One group of soldiers used a special program that emphasized lower total running mileage, gradual increases in running mileage, and the systematic introduction of interval training. In the special program, ability group runs changed pacing throughout each single running session (slow-fast-slow). Weekly distance increased from 3.0 miles in the first week to 8.0 miles in the seventh week. Interval training was introduced in the fourth week and involved nine-¼ mile repeats at a pace 5-7 seconds faster than the 2-mile pace achieved on the first APFT. Total run distance over the 8-week study was 47.5 miles with 37 miles of long-slow sustained running and 10.5 miles of intervals. It is not clear how far the traditional group ran but an estimate of 65 miles can be made based on the information provided in the article (assumes 3 days/wk of running with 2.7 miles each session); interval training was also performed about once a week. The traditional group and special group were two consecutive10-week medic AIT companies, which reduced differences that may be associated with turnover of training cadre. End-of-cycle reviews showed that the special program had 40% fewer limited duty profiles than the traditional program (26% vs. 43%, $p<0.01$). Compared to men and women in the traditional program, men in the special program had 62% fewer profiles (29% vs. 11%, $p<0.01$) and women in the special program had 17% fewer profiles (54% vs. 45%, $p>0.05$). The number of clinic visits for musculoskeletal complaints was 3.5 visits/100 soldiers for the traditional group and 2.2 visits/100 soldiers for the special group (37% lower for the special group). There were no differences between the groups in APFT pass rates, total APFT scores (points), or in 2-mile run scores (points). This study demonstrated that a program emphasizing lower total mileage, gradual increases in mileage, and

program, men in the special program had 62% fewer profiles (29% vs. 11%, $p<0.01$) and women in the special program had 17% fewer profiles (54% vs. 45%, $p>0.05$). The number of clinic visits for musculoskeletal complaints was 3.5 visits/100 soldiers for the traditional group and 2.2 visits/100 soldiers for the special group (37% lower for the special group). There were no differences between the groups in APFT pass rates, total APFT scores (points), or in 2-mile run scores (points). This study demonstrated that a program emphasizing lower total mileage, gradual increases in mileage, and systematic introduction of interval training can reduce the number of limited duty profiles and the number of clinic visits while maintaining APFT pass rates and 2-mile run scores.

4. PURPOSE OF PROJECT. This project was designed to examine the effectiveness of a multiple intervention program on injuries and fitness among Ordnance School AIT students. Interventions included modifications to the physical training program, injury-reduction education to the training cadre, and introduction of a unit based injury surveillance system.

5. METHODS.

a. Participants. Participants were soldiers attending AIT at APG (Edgewood Area) from 24 January 2000 to 29 March 2002. Soldiers in the Edgewood Area of APG train to qualify for one of five different Military Occupational Specialties (MOS). These MOS include Self Propelled Field Artillery System Mechanic (MOS 63D) which is 10 weeks in length, Fuel and Electrical System Repairer (MOS 63G) which is 9 weeks in length, Track Vehicle Repairer (MOS 63H) which is 16 weeks in length, Wheel Vehicle Repairer (MOS 63W) which is 13 weeks in length, and Track Vehicle Mechanic (MOS 63Y) which is 12 weeks in length. There are three companies (Alpha, Bravo, and Charlie) in the single training battalion at the Edgewood Area of APG (143rd Ordnance Battalion). The number of soldiers in each company at any one time ranges from a low of about 50 to a high of about 250. Soldiers of any MOS can be in any of the three companies.

b. Design. This study compared two cohorts of AIT soldiers. One cohort was called the historical control (HC) group. The HC group was comprised of AIT soldiers attending AIT from 24 January 2000 to 20 July 2001. The experimental injury management (IM) group was comprised of AIT soldiers attending AIT between 23 July 2001 and 29 March 2002. Soldiers whose attendance at the Ordnance School overlapped the time periods for both groups were not considered in the analysis. No training was performed during a 2-week period over the Christmas and New Year holidays (21 December 2000 to 7Janurary 2001 and 20 December 2001-6 January 2002)

c. Interventions. IM group interventions included: 1) the introduction of Physical Readiness Training (PRT), 2) an eight-hour education course provided to the training cadre and the command group, and 3) a battalion-based injury surveillance system. Each of these is described below.

(1) PRT. PRT is the Army's emerging physical fitness doctrine. The theoretical rationale and exercises involved have been described in several publications (4, 53). The program was shown to reduce injury rates in BCT (53). PRT involves a series of exercises that includes calisthenic drills, guerilla drills, dumbbell exercises, climbing drills, recovery drills, push-up/sit-up improvement, interval training, and ability group long-slow sustained running.

(a) A full description of each exercise is given elsewhere (4). Briefly, each PRT session was broken down into the preparation, activity, and recovery phases. The purpose of the preparation phase was to "warm up" the soldier for higher intensity exercises by performing basic calisthenic and guerilla drills. Calisthenic exercises included the bend and reach, the rear lunge and reach, the high jumper, the rower, the power squat, the windmill, the forward lunge and reach, the turn and reach, the squat thrust, the squat stepper, the bent-leg body twist, and the push-up. Guerilla drills (formerly called movement drills, (53)) included verticals, laterals, crossovers, the backward run, power skip, and accelerations. The purpose of the activity phase was to develop strength, endurance, and mobility through a mix of dumbbell exercises, climbing drills, and running exercises. Dumbbell drills included the lift and carry, the bent-over row, the rear lunge, the upright row, the forward lunge, and the curl and press. Climbing drills included the shoulder pull up, the heel hook, the pull-up, the curl-up, the chin-up, and the negative pull-up. Interval training was performed on a circular track and involved alternating 30 seconds of maximal speed runs (sprints), followed by 90 seconds of walking. Six to ten repetitions were performed. Ability group and unit formation long-slow sustained running involved runs of no more than 2 miles. The purpose of the recovery phase was to gradually taper activities to bring the cardiovascular system back to its pre-exercise state. Recovery drills included the rear lunge and reach, the flex and extend, the turn and reach, the groin and hamstring stretch, the thigh stretch, and the hip stretch. The total amount of time per training session generally did not exceed 60 minutes.

(b) Soldiers trained 5 days a week. Daily training was organized such that calisthenic exercises were performed first, followed by guerilla drills. On alternate days either climbing drills or dumbbell drills were performed. Interval training was performed one to two times each week and long-slow sustained ability group runs were performed about once a week. Company-level personnel conducted all physical training.

(c) Soldiers began the PRT program on 23 July 2001. For the first week, soldiers performed 4 repetitions of each calisthenic exercise,

guerilla drill, dumbbell drill, and climbing exercise. This was to emphasize precision of movement and allow soldiers to adapt to the exercises. In subsequent weeks, soldiers gradually progressed until a total of 10 repetitions of each exercise were performed. Additional push-up and sit-up exercises were performed.

(d) When a new soldier arrived after 23 July 2001, they performed physical training in an introductory training group that was separated from their company. Four repetitions were performed of each calisthenic exercise, guerilla drill, dumbbell drill, and climbing drill. This allowed the new soldier to learn the exercises with precision and provided for the gradual introduction of exercise stress. The following week, the soldier was integrated into his or her regular company to do 10 repetitions of each exercise.

(e) Study investigators monitored PRT on a daily basis. At least one individual (and sometimes as many as seven) rotated through the three companies and observed the training. Deviations from the training protocol were reported to the project monitors who sent the information to the battalion S-3 (Plans, Training, and Operations Office). The battalion S-3 informed the battalion commander and company commanders of the deviations. Company commanders had the responsibility to assure that corrections were made immediately and that the PRT program was conducted according to the training protocol.

(f) Remedial Physical Training (RPT). The 143rd Ordnance instituted a RPT program on 7 November 2001 (Week 16 of the 36 week project period). The reason for this was an anecdotal perception that more soldiers were failing the APFT than had failed in previous times. RPT was given to all soldiers who failed the diagnostic APFT (given in the fourth week of a soldier's training) or the first final APFT. RPT involved a second physical training session given in the evening at 1715 for one hour on three days of the week (Monday, Wednesday, and Friday). Again, this was in addition to their participation in the five-day PRT sessions held in the morning. Soldiers remained in RPT until they passed the APFT. APFTs were given weekly. Activities in RPT involved push-up/sit-up improvement exercises, cardiorespiratory training and nautilus circuit training.

(g) The HC group had a program called the Specialized Individualized Fitness (SIF) program that served a purpose similar to RPT. However, no systematic data had been maintained on soldiers in this program. The SIF program was conducted during the HC portion of this study.

(h) Reconditioning PRT (RPRT). Soldiers attended RPRT if they received a limited-duty profile that excused him or her from some or all of physical training. This group was closely supervised by at least three drill sergeants (and sometimes as many as six). Supervisors allowed soldiers to modify training within the limits of the profile. Occasionally, some soldiers

stayed with the RPRT group through some portion of their recovery period after the profile expired. It was up to the RPRT leaders to determine when a soldier could successfully re-join his or her company PRT sessions.

(2) Education Program. An 8-hour block of instruction on injury control techniques was given to the 143rd Ordnance drill sergeants, NCO instructors, and officers on 31 July 2002 and 1 August 2001. The two training sessions were identical; different personnel attended each session. The training consisted of five modules involving common physiological principles and injury-control research.

(a) The introductory module helped the audience gain an appreciation for the burden injuries place on the Army. This module emphasized that reducing injuries was in the hands of the drill sergeants and the command group. It was emphasized that the project had command endorsement from the Deputy Commander of TRADOC for Initial Entry Training on down the chain-of-command. Differences in acute and overuse injuries were explained. Overuse injuries were discussed as being due to repetitive actions that are largely preventable. Common causes of injuries at Edgewood were discussed. The risk management approach to reducing injuries was emphasized (identify hazards, determine risks, develop controls and make risk decisions, implement controls, supervise and evaluate). This module concluded with a discussion on the need to transform Army culture by shifting the injury paradigm – or changing the way we think about injuries in the Army.

(b) A second module involved physical training and sports. Speakers emphasized that these were the leading activities associated with injuries both at Edgewood and in the Army in general. Training-related risk factors (low physical activity, low fitness, long running mileage) were discussed. The influence of running mileage on injuries was covered and the concept of gradually increasing training intensity was emphasized. The importance of warming up prior to exercise was introduced and it was pointed out that stretching prior to exercise does not appear to influence injury rates. General training concepts (progression, regularity, overload, variety, recovery, balance, specificity, and precision) were discussed as well as frequency, intensity, and duration of exercise. It was brought to light that any violation of these principles may result in increased risk of sustaining training related injuries.

(c) A third module involved work tasks and equipment and their relationship with injuries. Ergonomic concepts, goals and work-related injury risk factors were discussed. Everyday examples of risk factors were provided. Signs that indicate problems (e.g., soldier changes to the working environment) were discussed. How to engineer design solutions through anthropometrics was discussed. Biomechanics of lifting and manual materiel handling was covered, as was research on back belts.

(d) A fourth module presented factors that contributed to injury. These included personal characteristics (such as gender, age, anatomical variations, tobacco use) and external characteristics (such as running mileage, weather, and running shoes). Specific modifiable risk factors were discussed (pads, wrist & ankle braces, BMI, uncontrolled anger, stressful life events, fatigue). Running shoe selection, seat belt use, blister prevention, nutrition, and alcohol use, were also highlighted. The instructor emphasized the importance of responsible leadership and intervening early, while an injury is in its infancy.

(e) The fifth and final module consisted of injury management and a practical exercise. The risk management process was reviewed and the Injury Control Advisory Committee was introduced as a tool to advise the commander on how to reduce injuries. A final exercise applied what had been learned in previous modules using the risk management process to examine simulated injury problems.

(3) Battalion Surveillance System.

(a) The Battalion Surveillance System was designed to enable the leadership to benchmark their injury rates, assess the source or cause of most injuries, and hopefully drive changes that might reduce injuries. The system was placed on each company's computer just prior to the start of the IM period. It consisted of a Microsoft Access relational database that was linked to each training company's personnel roster database. Following a soldier's visit to the medical treatment facility, the company's operation sergeant could enter data from the limited-duty profile form (Appendix B) completed by the medical provider. Through the use of drop-down menus or auto-complete typing, it would take the operations sergeant about 45 seconds to enter data on one soldier. Data entered into the system included name, initial or follow-up visit, injury or illness, body part, complaint, whether injury or illness existed prior to AIT (or developed in AIT), associated activity, overuse or acute, injured on/off duty, profile start date, profile end date, selections from a menu of duty limitations, and an optional free text field.

(b) These data enabled the generation of a selection of real-time graphs and charts. Prior to the deployment of this unit surveillance system, it was not known how much detail the company commanders and battalion commander would consider useful. Thus, the following 18 variables and graphs were offered: injury rate, injuries by body part, injuries by associated activity, overuse injuries, injuries by AIT status, physical profile report, time lost due to injuries, injuries on duty, injuries by complaint, injuries by primary MOS, injuries by basic training site, injuries by age of running shoes, running shoe age, top 10 complaints by body part, overuse injuries by body part, injuries by component (reserve or active duty), and visit type (initial or follow-up).

(c) Note that the Battalion Surveillance System was not used to calculate the injury outcome measures in this study. This was because it was not in place during the HC period. The injury outcomes were determined using the Clinic Surveillance System that will be described later.

d. Data Collected.

(1) Training Observations. In the HC group, training was observed for a 3-week period (13 April 2001 to 4 May 2001) prior to the start of the injury control measures. There were 16 days of observations since soldiers trained 5 days per week. Observers watched running within the three companies, especially how far they ran, how long they ran, and whether or not interval training was conducted. In the IM cohort, running was recorded from the training schedules since training companies were required to conform to the schedule. Running distances and times were generally observed but not specifically recorded in the IM group.

(2) Demographics, Lifestyle Characteristics, & Administrative Data.

(a) Soldier Health Inprocessing (SHIP) Questionnaire. When soldiers arrived at AIT from BCT they were inprocessed on a single day. During the study period, groups of 3 to 85 soldiers (average=39) were inprocessed each week. As part of inprocessing procedures, soldiers were asked to fill out the SHIP questionnaire. Each question on the form was completed by the soldier after a moderator read the question to the group. The survey instrument contained questions on date of birth (for age calculation), gender, race, the soldier's BCT site, whether or not the soldier currently had an injury or illness that would affect their AIT performance, and their tobacco use history. The SHIP questionnaire is at Appendix C.

(b) Administrative Data. The Department of Academic Affairs at APG provided monthly data from the local Army Training and Resource Requirements System (ATRRS) on each Ordnance School student. These data included MOS, component (active Army, reserve, national guard), date of arrival at APG, and date of departure from APG.

(3) Clinic Surveillance System. Every time a soldier reported to the clinic at Edgewood, a medic, physician's assistant, or physician would fill out the injury sheet shown in Appendix D. Note that these sheets were filled out only for sick call visits. Visits to specialty clinics (e.g., physical therapy, podiatry) or consults outside the hospital were not captured. However, these latter visits were likely to be follow-up visits since the soldier first had to report to the clinic for any medical problem. Since the primary injury measures involved whether or not the soldier was injured and when the injury occurred, little data was lost. Data from the injury sheets were used to determine injury outcomes.

(a) An injury was defined as physical damage to the body (28) for which the soldier sought medical care. Using the diagnosis on the injury sheet, injuries were grouped by "type" for analysis. "Types" included any time-loss injury, time-loss overuse injuries, and time-loss traumatic injuries. All injury types required some limitation of duty (i.e., time-loss) prescribed by the medical care provider. Injury types were determined by diagnosis. Overuse injuries were those presumably due to or related to long-term energy exchanges resulting in cumulative microtrauma and included musculoskeletal pain (not otherwise specified), stress fractures, stress reactions, tendinitis, bursitis, fasciitis, arthritis, neuropathy, radiculopathy, shin splints, synovitis, and strains. Traumatic injuries were those presumably due to sudden energy exchanges resulting in abrupt overload and included pain (due to a traumatic event), sprains, dislocations, fractures, blisters, abrasions, lacerations, contusions, and subluxations. Environmental injuries (which included heat-related injuries, cold-related injuries, and insect bites) were not included in the analysis. These definitions are consistent with those used in past investigations (10, 11, 35, 38, 46, 49, 53, 54, 58, 63).

(b) In addition to the Battalion Surveillance System described above (one of the interventions), data from the Clinic Surveillance System were provided to the 3 company commanders and to the battalion commander. Data was provided in the form of a graph, an example of which is shown in Figure 2. Data given to commanders (Figure 2) were the number of soldiers reporting to the clinic each week. A soldier was only reported once per week even if he or she had multiple visits in a single week. If the soldier returned the following week for a visit, that soldier was counted for that week. Each Friday, graphs were sent by e-mail to the commanders. Commanders received these graphs throughout the study period (January 2000-March 2002), and graph formats remained the same during the entire time.

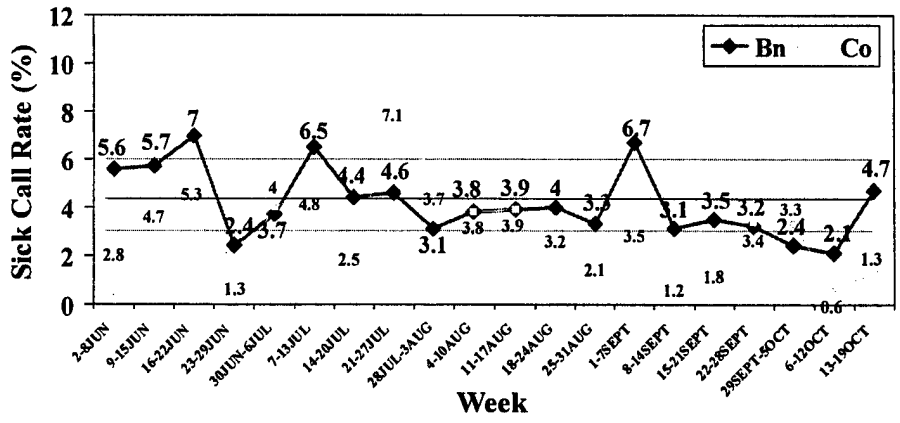
(4) Army Physical Fitness Test (APFT). APFT data were obtained from the 143rd Ordnance Battalion S-3 office. Initial and final APFTs were administered every Wednesday to all trainees who needed them by the battalion staff with help from each company. APFT data were provided to USACHPPM in an Excel spreadsheet with identification of each test as an initial test or a final test. Initial tests were given within the first week of arrival. The first final test was generally given in the eighth week of training. Soldiers had to meet age and gender adjusted standards in order to "pass" the APFT (3). Soldiers who did not pass the first final test were given additional APFTs and there were no limits on the number of additional tests that could be given. Soldiers who could not pass the final APFT after all retakes (i.e., was not showing progressive improvement) were discharged from service.

(a) In addition to initial and final APFTs, the individual companies administered diagnostic tests during the fourth week of training.

These data were generally not reported to the S-3 office and could not be systematically obtained for the purposes of this study.

(b) The APFT consisted of three events: push-ups, sit-ups and a 2-mile run, conducted in that order. For the push-up, the soldier was required to lower his or her body in a generally straight line to a point where his/her upper arms were parallel to the ground, then return to the starting point with elbows fully extended. For the sit-up, the soldier was supine with knees upward and bent at a 90° angle. Fingers were interlocked behind the head, and a second person held the participant's ankles, keeping the participants heels firmly on the ground. The soldier raised his or her upper body to a vertical position so that the base of the neck was anterior to the base of the spine and then returned to the starting position. The number of push-ups and sit-ups that were successfully completed in separate 2-minute periods were recorded. For the 2-mile run, time to complete the distance was the performance measure.

Figure 2. Sample Graph From Clinic Injury Surveillance System Showing Battalion (Bn) and Company (Co) Injury Sick Call Rates



Note: Solid line represents the average in the last quarter.

(5) Six Item Physical Fitness Test (SIPFT).

(a) Besides the APFT, soldiers were asked during inprocessing to volunteer for the SIPFT. Since this part of the study was not part of a soldier's normal training and duties, only volunteers were tested in accordance with Army Regulation 70-25. The SIPFT was given on the first week of arrival at APG (pretest) and the eighth week of training (post test). The design used for the SIPFT differed from that of the rest of the study. The SIPFT was evaluated on two groups of soldiers at the same time. The experimental group was made up of soldiers from the 143rd Ordnance Battalion who were a subsample of the IM group. The control group was from the 16th Ordnance

Battalion, located at the Aberdeen Area of APG. The 16th Ordnance Battalion consisted of AIT soldiers training in 10 different Ordnance specialties. This portion of the study compared the PRT program (143rd Ordnance soldiers) against a traditional AIT physical training program (16th Ordnance Soldiers) on selected measures of physical performance.

(b) The SIPFT consisted of a standing long jump, power squat, heel hook, 300-yard shuttle run, push ups and 1-mile run, administered in that order. For the standing long jump, the soldier stood behind a line and then jumped as far forward as possible. The scorer marked the distance from the jump line to the landing point of contact (heel) nearest the jump line. Soldiers were given two jumps and the longer was recorded. For the power squat, the soldier assumed a straddle stance (leg apart) with hands on hips. He or she repeatedly lowered and raised his/her body. In the fully down position, the soldier's back was straight (though the trunk could be tilted forward at the hip), heels remained in contact with the ground, the thighs were parallel with the ground, and the arms were extended forward and parallel to the ground with palms facing each other. The soldier had 1 minute to perform as many repetitions as possible. For the heel hook, the soldier mounted one end of a pull up bar, grasped the bar,and hung from the bar with an alternating grip such that his/her body faced a supporting post. The soldier attempted to raise his/her feet above the bar such that both feet were above the bar and resting on it (or one foot hooked on top of the other). Two spotters were used, one positioned on each side of the soldier. The number of repetitions in 1 minute was counted. For the 300-yard shuttle run, the soldier ran to a line on the ground 25 yards from the starting position, reached down and touched the line, and then returned to touch the starting position. The soldier ran down and back a total of six times. The time to complete the circuit was recorded. For the push-up, the soldier assumed a front leaning rest position with hands directly under the shoulders, elbows straight but not locked (pointing backwards), with feet together. The soldier lowered his/her body until the upper arm was parallel to the ground with the elbows held tightly against the trunk, then returned to the starting position. The number of repetitions in 1 minute was recorded. For the 1-mile run, time to complete the distance was recorded.

e. Data Analysis. Because of the different types of information collected in this study, the statistical analyses are described in detail in the Results section where the specific data are presented. In general, frequency data involving counts of people were analyzed using the Pearson chi-square test of proportions. To examine differences between groups or conditions where continuous variables were involved, t-tests, analysis of variance (ANOVA), or analysis of covariance (ANCOVA) were used. Survival analysis (Cox regression) was used to analyze differences in injury risk. The Statistical Package for the Social Sciences (SPSS), Version 10.0.5, was used for these analyses.

6. RESULTS. There were 1,122 men and 161 women in the IM cohort; there were 2,303 men and 256 women in the HC cohort. There were 352 men and 40

women who were already present when the IM measures began and these were not included in either cohort. Thus, only soldiers who completed AIT prior to the IM control measures were included in the HC group; only soldiers who entered AIT after the IM measures were in place were included as members of the IM group.

a. Demographic, Lifestyle, and Administrative Comparisons. Table 1 shows comparative demographics, lifestyle characteristics, and administrative measures on the two groups. Group differences were analyzed using the chi-square test of proportions.

(1) Among the men, there were differences in the proportion of soldiers in the two groups by rank, MOS, race, BCT location, and number of soldiers injured on entry. For rank, the IM group had more E1s while the HC group had more E2s. With regard to MOS, IM group had more 63H and 63Y while the HC group had more 63W and 63D. For race, the IM group had more Caucasians and the HC group had more African Americans. For BCT location, the IM group had more soldiers from Ft Jackson while the HC group had more soldiers from Ft Knox and Ft Benning. More of the soldiers in the HC group reported that they had a BCT injury likely to affect their performance in AIT.

(2) Among the women, there were differences in the proportion of soldiers by MOS, and BCT location. For MOS, the IM group had more 63H and 63Y while the HC group had more 63W. With regard to BCT location, more of the IM group came from Ft Jackson while more of the HC group came from Fort Leonard Wood and Ft Sill. Ft Benning trains no women accounting for the lack of women from this BCT location. There were no women in MOS 63D at APG.

(3) There were no group differences for the four tobacco use questions. Of the men who reported smoking on 20 of 30 days prior to BCT, 20% of them also reported using smokeless tobacco on 20 of 30 days prior to BCT (HC and IM groups combined). Of the women who reported smoking on 20 of 30 days prior to BCT, 7% of them also reported using smokeless tobacco on 20 of 30 days prior to BCT (HC and IM groups combined).

(4) Table 2 shows the age and fitness comparisons of the two groups on entry to APG. Push-up, sit-up and 2-mile run scores are from the initial APFT. Group differences were analyzed using an unpaired t-test. The two groups of men differed significantly on age, push-up performance, and sit-up performance. The two groups of women differed only on push-up performance. In general, men and women in the HC group were more fit than those in the IM group.

Table 1. Comparison of the Two Cohorts on Demographics, Lifestyle Characteristics and Administrative Measures

Variable	Category	Men			Women		
		IM (%)	HC (%)	p-value	IM (%)	HC (%)	p-value
Rank[a]	E1	64.7	60.4		58.4	52.0	
	E2	19.5	22.8		21.7	25.8	
	E3	13.4	13.1	0.02	15.5	18.4	0.59
	E4	2.4	3.8		4.3	3.9	
MOS[bc]	63G	8.5	8.6		6.8	5.1	
	63W	59.4	61.7		68.3	83.2	
	63D	5.3	9.6	<0.01	0.0	0.0	<0.01
	63H	12.7	10.2		14.3	9.8	
	63Y	14.1	9.9		10.6	2.0	
Race[a]	Black	11.5	16.3		21.5	20.6	
	Caucasian	63.8	61.3		58.4	61.0	
	Hispanic	14.8	14.2	<0.01	8.7	9.6	0.56
	Other	9.9	8.2		8.7	11.4	
BCT Location[ab]	Ft. Jackson	24.2	10.7		81.9	64.1	
	Ft. Knox	56.8	67.4		0.7	0.5	
	Ft. LW[d]	6.0	4.3	<0.01	12.8	18.6	<0.01
	Ft. Benning	7.8	11.3		0.0	0.0	
	Ft. Sill	4.0	4.2		4.0	15.5	
	Other	1.2	2.1		0.7	1.4	
Injury on Entry[a]	Yes	7.4	9.7	0.04	19.6	16.9	0.51
	No	92.6	90.3		80.4	83.1	
Illness on Entry[a]	Yes	2.0	2.9	0.14	4.1	2.7	0.48
	No	98.0	97.1		95.9	97.3	
Cigarette Smoking (Once in 30 days before BCT)[a]	Yes	43.3	45.7	0.23	40.9	41.4	0.93
	No	56.7	54.3		59.1	58.6	
Cigarette Smoking (20 of 30 days before BCT)[a]	Yes	37.0	37.9	0.40	35.6	34.8	0.69
	No	62.1	60.6		64.4	64.7	
Smokeless Tobacco (Once in 30 days before BCT)[a]	Yes	16.9	17.0	0.92	5.4	3.6	0.41
	No	83.1	83.0		94.6	96.4	
Smokeless Tobacco (20 of 30 days before BCT)[a]	Yes	12.4	12.7	0.82	3.4	3.0	0.86
	No	87.6	87.3		96.6	97.0	

[a]From SHIP Questionnaire
[b]In analysis of rank, MOS, and BCT location, zero cells were not included in the analysis
[c]From administrative data
[d]Ft. LW=Ft Leonard Wood

Table 2. Age and Fitness Comparison of the Two Cohorts

Variable	Men			Women		
	IM	HC	p-value[a]	IM	HC	p-value[a]
Age (yrs)	19.8±2.8	20.4±3.3	<0.01	20.1±3.3	20.4±3.2	0.48
Push-Ups (reps)	50.4±11.4	53.8±12.5	<0.01	28.8±9.5	33.7±11.6	<0.01
Sit-Ups (reps)	61.0±9.9	62.5±10.2	<0.01	59.8±10.8	61.8±11.9	0.22
2-Mile Run (min)	14.9±1.4	14.9±1.4	0.69	18.4±2.3	18.3±2.0	0.88

[a]From unpaired t-test

b. Physical Training Observations.

(1) A total of 42 observations were made on the 3 companies of the HC group during the 16 days of observations prior to the start of the injury control measures. Six sessions were missed because of observer scheduling conflicts. Physical training was conducted 5 days/wk and the average±SD time was 61±13 min. There were 6±10 min of administrative announcements, 15±6 minutes of warm-up and stretching, 17±14 minutes devoted to calisthenics. An average (±SD) of 7±8 min of push-ups and 13±7 minutes of sit-ups were performed. Administrative announcements were conducted in 29 sessions, stretching was performed in 38 session, calisthenics in 22 sessions, sit-ups in 8 sessions, and push-ups in 19 sessions. There were a total of 18 formation runs performed during the 42 sessions (44% of all physical training sessions). The average±SD time for the 18 runs was 27.8±5.1 min and the average±SD distance was 3.1±0.7 miles. Thus, long-slow sustained running was performed an average of 2.3 days/wk for an average of 7.1 miles/wk. Seven of the 42 sessions involved interval running (17% of all physical training sessions) with 2 of the 7 interval sessions involving both intervals and long distance running. Thus, interval runs were performed 0.8 days/wk on average. Running (intervals and/or long-slow sustained runs) was performed on 23 sessions for an average of 2.9 days/wk.

(2) The IM group performed calisthenics and guerrilla drills every training day. Climbing drill, dumbbell exercises and push-up/sit-up improvement was performed an average±SD of 1.9±0.3 times/week, 1.3±1.1 times/week and 1.9±0.3 times/week, respectively. There was an average±SD of 1.6±1.5 interval running sessions per week and 0.9±0.7 ability group runs per week. Thus, running (intervals and ability group running) was performed 2.5 days/week and did not exceed 2 miles in any single run. The three companies had 50 to 52 interval sessions and 30 to 32 ability group running sessions over the 36 weeks of the project.

c. Injury Outcomes.

(1) Table 3 shows the person-time injury incidence rates for the two groups and the 3 injury outcome measures. In all cases for both men and women, rates are higher for the HC group than for the IM group.

Table 3. Person-Time Injury Incidence Rates (Injuries/100 person-months)

Group	Gender	Any Time-Loss Injury	Time-Loss Overuse Injury	Time-Loss Traumatic Injury
HC	Men	10.3	7.5	3.4
	Women	15.5	13.4	4.6
IM	Men	9.7	6.7	2.5
	Women	14.0	9.7	3.3

(2) Cox regression (a survival analysis technique) was used to examine injury risk associated with the various covariates (Tables 2 and 3) and to examine differences in injury risk between the IM and HC groups with covariates controlled. Gender-specific analyses were conducted for each of the three injury variables (any time-loss injury, time-loss overuse injury, and time-loss traumatic injury). For each analysis, once a soldier had an injury, his or her contribution to time in AIT was terminated. Those not completing AIT (discharges) had their times censored at the day they left the unit. Soldiers of different MOS and those who remained longer in the unit (newstarts) had their additional time included. All covariates were entered into the regression model as categorical variables. Continuous APFT variables were converted into four approximately equal sized groups (gender specific) based on the distribution of scores for each event (quartiles). Age was collapsed to four categories (17-19, 20-24, 25-29, and >29 years). For all categorical variables, simple contrasts with a baseline variable (defined with a risk ratio of 1.00) were used. Because of the similarity of two questions on cigarette smoking (SHIP Questions 18 and 19, Appendix C), only responses to the question on smoking on 20 of the 30 days before BCT were included in the analysis (SHIP Question 19). Likewise, because of the similarity of two questions on smokeless tobacco use (SHIP Questions 20 and 21, Appendix C), only responses to the question on use on 20 of the 30 days before BCT were included in the analysis (SHIP Question 21).

(3) Both univariate and multivariate Cox regressions were performed. Univariate analysis considered each covariate individually, including group (HC or IM). Separate analyses were performed for each of the 3 injury variables. Covariates were selected for the multivariate analysis if they had a p-value of 0.25 or less in the univariate analyses, and/or if there was a biologically plausible relationship between the covariate and injury (33) based on past investigations (40, 56). Multivariate models were developed for the selected covariates with each of the three injury variables as dependent factors.

(4) Univariate Analysis of Injury Risk.

(a) Table 4 shows the univariate analysis with time to the first time-loss injury as the dependent variable. For the men, risk of injury was higher among soldiers with lower rank, prior injury, prior cigarette smoking, and lower initial performance on push-ups, sit-ups, and the 2-mile run. In addition, men of "other" races were at greater injury risk than Hispanics. With regard to age, 20-24 year olds were at greater risk than 17-19 year olds but there was a

tendency for older age groups to have progressively higher risk. For women, risk of injury was higher among soldiers with prior injury, prior cigarette smoking, and lower performance on push-ups or the 2-mile run. In contrast to men, Hispanic women were at greater injury risk than those of "other" race. There was a tendency for the HC group to be at greater injury risk than the IM control group among both men and women, but this was not statistically significant.

(b) Table 5 shows the univariate analysis for each covariate with time to the first time-loss overuse injury as the dependent variable. For the men, injury risk was higher among soldiers in the HC group, with lower rank, prior injury, prior cigarette smoking, lower push-up performance, lower sit-up performance, slower times on the 2-mile run, and older age. For the women, injury risk was higher among those in the HC group, prior injury, using smokeless tobacco, and those with lower push-up or 2-mile run performance.

(c) Table 6 shows the univariate analysis for each covariate with time to the first time-loss traumatic injury as the dependent variable. For the men, risk of injury was higher among soldiers in the HC group, those with prior injury, prior cigarette smokers, and those with lower performance on sit-ups or the 2-mile run. Also, men who completed BCT at Ft Jackson were at lower injury risk than those completing BCT at Ft Leonard Wood or Ft Benning. Among women, no single covariate emerged as increasing time-loss traumatic injury risk.

Table 4. Cox Regression Results for Any Time-Loss Injury (Univariate Analysis)

Variable	Level of Variable	Men			Women		
		Risk Ratio	95%CI[a]	p-value[b]	Risk Ratio	95%CI[a]	p-value[b]
Group	IM	1.00	----	----	1.00	----	----
	HC	1.13	0.98-1.30	0.10	1.31	0.96-1.79	0.09
Rank	PV1	2.04	1.24-3.30	<0.01	1.04	0.48-2.24	0.93
	PV2	1.64	1.00-2.69	0.05	1.03	0.46-2.29	0.95
	PFC	1.69	1.01-2.81	0.04	1.26	0.56-2.84	0.57
	SPC	1.00	----	----	1.00	----	----
MOS	63Y	1.00	----	----	1.00	----	----
	63G	1.15	0.85-1.55	0.36	0.67	0.27-1.67	0.92
	63W	1.10	0.90-1.35	0.36	0.77	0.42-1.43	0.93
	63D	1.06	0.78-1.45	0.71	----	----	0.95
	63H	0.98	0.75-1.29	0.90	0.92	0.45-1.88	0.57
Race	Other	1.00	----	----	1.00	----	----
	Black	0.88	0.65-1.16	0.33	0.80	0.42-1.51	0.48
	White	0.98	0.77-1.24	0.86	1.15	0.67-1.99	0.61
	Hispanic	0.68	0.50-0.92	0.01	1.94	1.00-3.75	0.05
Basic Training Site	Ft Jackson	1.00	----	----	1.00	----	----
	Ft Knox	0.99	0.81-1.20	0.89	3.67	0.90-14.89	0.07
	Ft LW[c]	1.13	0.81-1.59	0.47	1.08	0.72-1.62	0.73
	Ft Benning	0.99	0.75-1.31	0.94	----	----	----
	Ft Sill	1.24	0.87-1.77	0.24	1.04	0.66-1.65	0.87
	Other	0.52	0.25-1.06	0.07	1.42	0.35-5.75	0.62
Prior Injury	No	1.00	----	----	1.00	----	----
	Yes	2.33	1.92-2.83	<0.01	2.01	1.39-2.91	<0.01
Prior Illness	No	1.00	----	----	1.00	----	----
	Yes	1.30	0.90-1.92	0.19	0.97	0.42-2.21	0.93
Cigarette Smoking	No	1.00	----	----	1.00	----	----
	Yes	1.51	1.30-1.74	<0.01	1.42	1.02-1.98	0.04
Smokeless Tobacco Use	No	1.00	----	----	1.00	----	----
	Yes	1.11	0.90-1.37	0.33	1.63	0.72-3.70	0.24
Push Up Quartile (Q)	Q1(few)	2.22	1.82-2.70	<0.01	1.70	1.10-2.62	0.02
	Q2	1.36	1.10-1.67	<0.01	1.17	0.74-1.84	0.51
	Q3	1.21	0.98-1.49	0.09	0.70	0.42-1.18	0.18
	Q4(many)	1.00	----	----	1.00	----	----
Sit-Up Quartile (Q)	Q1(few)	2.20	1.79-2.70	<0.01	1.51	0.95-2.41	0.09
	Q2	1.67	1.34-2.07	<0.01	1.55	0.98-2.44	0.06
	Q3	1.52	1.22-1.89	<0.01	1.10	0.67-1.82	0.69
	Q4(many)	1.00	----	----	1.00	----	----
2-Mile Run Quartile (Q)	Q1(slow)	2.68	2.20-3.26	<0.01	2.73	1.71-4.36	<0.01
	Q2	1.55	1.25-1.92	<0.01	1.79	1.09-2.94	0.02
	Q3	1.14	1.91-1.43	0.24	1.45	0.88-2.40	0.15
	Q4(fast)	1.00	----	----	1.00	----	----
Age Group	17-19yrs	1.00	----	----	1.00	----	----
	20-24yrs	1.17	1.02-1.34	0.03	1.14	0.82-1.59	0.43
	25-29yrs	1.18	0.91-1.55	0.21	1.19	0.73-1.93	0.49
	>29yrs	1.38	0.98-1.96	0.07	1.48	0.80-2.73	0.21

[a]CI=Confidence Interval
[b]p-value from Wald statistic
[c]LW=Leonard Wood

Table 5. Cox Regression Results for Time-Loss Overuse Injury (Univariate Analysis)

Variable	Level of Variable	Men			Women		
		Risk Ratio	95%CI[a]	p-value[b]	Risk Ratio	95%CI[a]	p-value[b]
Group	IM	1.00	----	----	1.00	----	----
	HC	1.18	1.00-1.39	0.05	1.65	1.14-2.38	<0.01
Rank	PV1	2.31	1.27-4.20	<0.01	0.97	0.60-3.77	0.95
	PV2	1.79	0.97-3.31	0.06	0.94	0.42-2.24	0.89
	PFC	1.72	0.92-3.24	0.09	1.20	0.50-2.90	0.67
	SPC	1.00	----	----	1.00	----	----
MOS	63Y	1.00	----	----	1.00	----	----
	63G	1.09	0.78-1.54	0.62	1.09	0.37-3.27	0.87
	63W	1.00	0.79-1.26	0.99	1.18	0.52-2.71	0.69
	63D	0.89	0.61-1.29	0.52	----	----	----
	63H	0.84	0.61-1.15	0.28	1.50	0.60-3.77	0.38
Race	Other	1.00	----	----	1.00	----	----
	Black	0.94	0.66-1.35	0.75	0.60	0.31-1.17	0.13
	White	1.13	0.84-1.51	0.43	0.87	0.50-1.51	0.62
	Hispanic	0.75	0.52-1.09	0.13	1.21	0.60-2.46	0.59
Basic Training Site	Ft Jackson	1.00	----	----	1.00	----	----
	Ft Knox	0.99	0.79-1.25	0.95	2.31	0.32-16.67	0.41
	Ft LW[c]	0.90	0.59-1.38	0.63	1.35	0.86-2.12	0.19
	Ft Benning	0.96	0.69-1.34	0.82	----	----	----
	Ft Sill	1.20	0.79-1.83	0.39	1.05	0.61-1.82	0.85
	Other	0.55	0.24-1.25	0.15	1.94	0.48-7.87	0.36
Prior Injury	No	1.00	----	----	1.00	----	----
	Yes	2.20	1.75-2.76	<0.01	2.16	1.45-3.21	<0.01
Prior Illness	No	1.00	----	----	1.00	----	----
	Yes	1.19	0.75-1.91	0.46	1.01	0.40-2.51	0.99
Cigarette Smoking	No	1.00	----	----	1.00	----	----
	Yes	1.56	1.32-1.85	<0.01	1.30	0.90-1.88	0.16
Smokeless Tobacco Use	No	1.00	----	----	1.00	----	----
	Yes	1.19	0.94-1.52	0.15	2.41	1.06-5.49	0.04
Push Up Quartile (Q)	Q1(few)	2.99	2.35-3.81	<0.01	1.70	1.06-2.71	0.03
	Q2	1.58	1.22-2.04	<0.01	0.97	0.58-1.61	0.89
	Q3	1.38	1.06-1.81	<0.01	0.78	0.45-1.36	0.38
	Q4(many)	1.00	----	----	1.00	----	----
Sit-Up Quartile (Q)	Q1(few)	2.58	2.01-3.31	<0.01	1.59	0.96-2.68	0.07
	Q2	1.91	1.47-2.49	<0.01	1.54	0.93-2.55	0.09
	Q3	1.71	1.31-2.23	<0.01	1.15	0.66-2.00	0.62
	Q4(many)	1.00	----	----	1.00	----	----
2-Mile Run Quartile (Q)	Q1(slow)	2.93	2.32-3.71	<0.01	2.69	1.63-4.46	<0.01
	Q2	1.65	1.27-2.13	<0.01	1.62	0.94-2.79	0.08
	Q3	1.05	0.80-1.39	0.71	1.26	0.72-2.20	0.42
	Q4(fast)	1.00	----	----	1.00	----	----
Age Group	17-19yrs	1.00	----	----	1.00	----	----
	20-24yrs	1.28	1.09-1.51	<0.01	1.10	0.77-1.58	0.61
	25-29yrs	1.28	0.95-1.74	0.11	1.06	0.62-1.83	0.82
	>29yrs	1.58	1.07-2.34	0.02	1.58	0.83-2.99	0.17

[a]CI=Confidence Interval
[b]p-value from Wald statistic
[c]LW=Leonard Wood

Table 6. Cox Regression Results for Time-Loss Traumatic Injury (Univariate Analysis)

Variable	Level of Variable	Men			Women		
		Risk Ratio	95%CI[a]	p-value[b]	Risk Ratio	95%CI[a]	p-value[b]
Group	IM	1.00	----	----	1.00	----	----
	HC	1.38	1.06-1.81	0.02	1.40	0.75-2.62	0.29
Rank	PV1	1.94	0.80-4.72	0.14	2.16	0.29-15.81	0.45
	PV2	1.66	0.67-4.14	0.28	1.72	0.22-13.32	0.60
	PFC	2.11	0.84-5.33	0.11	1.06	0.12-9.11	0.96
	SPC	1.00	----	----	1.00	----	----
MOS	63Y	1.00	----	----	1.00	----	----
	63G	1.32	0.73-2.37	0.36	0.49	0.04-5.38	0.55
	63W	1.42	0.94-2.14	0.10	1.12	0.27-4.66	0.48
	63D	1.44	0.80-2.59	0.23	----	----	----
	63H	1.45	0.88-2.39	0.15	1.28	0.26-6.18	0.76
Race	Other	1.00	----	----	1.00	----	----
	Black	0.85	0.52-1.38	0.51	0.66	0.15-2.98	0.59
	White	0.80	0.53-1.19	0.26	1.76	0.53-5.78	0.36
	Hispanic	0.64	0.39-1.08	0.10	1.84	0.44-7.71	0.41
Basic Training Site	Ft Jackson	1.00	----	----	1.00	----	----
	Ft Knox	1.36	0.91-2.02	0.14	1.10	0.24-3.31	0.98
	Ft LW[c]	2.23	1.25-3.95	<0.01	0.91	0.38-2.20	0.84
	Ft Benning	1.79	1.08-2.96	0.02	----	----	----
	Ft Sill	1.64	0.83-3.23	0.15	1.10	0.43-2.86	0.84
	Other	0.29	0.04-2.09	0.22	1.80	0.24-13.50	0.57
Prior Injury	No	1.00	----	----	1.00	----	----
	Yes	1.80	1.26-2.58	<0.01	1.35	0.61-2.96	0.45
Prior Illness	No	1.00	----	----	1.00	----	----
	Yes	1.19	0.59-2.40	0.63	1.23	0.29-5.18	0.78
Cigarette Smoking	No	1.00	----	----	1.00	----	----
	Yes	1.38	1.07-1.79	0.02	1.72	0.91-3.27	0.09
Smokeless Tobacco Use	No	1.00	----	----	1.00	----	----
	Yes	0.98	0.66-1.44	0.09	0.88	0.12-6.41	0.90
Push Up Quartile (Q)	Q1(few)	1.04	0.74-1.46	0.83	1.68	0.79-3.57	0.17
	Q2	0.94	0.68-1.31	0.94	1.14	0.52-2.51	0.75
	Q3	0.81	0.57-1.15	0.81	0.18	0.04-0.82	0.03
	Q4(many)	1.00	----	----	1.00	----	----
Sit-Up Quartile (Q)	Q1(few)	1.61	1.14-2.29	<0.01	1.65	0.72-3.85	0.24
	Q2	1.37	0.95-1.97	0.09	1.42	0.61-3.30	0.41
	Q3	1.19	0.82-1.73	0.35	1.03	0.40-2.66	0.96
	Q4(many)	1.00	----	----	1.00	----	----
2-Mile Run Quartile (Q)	Q1(slow)	1.69	1.20-2.38	<0.01	2.16	0.92-5.13	0.08
	Q2	1.27	0.88-1.83	0.20	1.32	0.51-3.43	0.57
	Q3	1.05	0.72-1.53	0.80	1.78	0.74-4.31	0.20
	Q4(fast)	1.00	----	----	1.00	----	----
Age Group	17-19yrs	1.00	----	----	1.00	----	----
	20-24yrs	0.93	0.72-1.20	0.57	1.21	0.64-2.29	0.56
	25-29yrs	1.10	0.69-1.76	0.68	1.53	0.62-3.76	0.36
	>29yrs	0.99	0.50-1.93	0.97	0.39	0.05-2.95	0.37

[a]CI=Confidence Interval
[b]p-value from Wald statistic
[c]LW=Leonard Wood

(5) Multivariate Comparison of HC and IM Groups.

(a) Tables 7 to 9 display the results of the multivariate analyses showing the risk of injury in the HC group relative to the IM group while controlling for the influence of the other variables. The blank rows in the tables indicate variables not included in the multivariate analysis because that variable did not reach the pre-established $p<0.26$ criterion in the univariate analyses. The group variable was included in all analyses since this was the major variable of interest. All three physical fitness variables (push-ups, sit-ups, and 2-mile run) and prior cigarette smoking were included in all analyses since many studies have shown that these are related to injury risk (1, 31, 35, 36, 50, 62, 63, 75, 97) and the relationships have biological plausibility (1, 63).

(b) Table 7 displays the results of the multivariate analysis showing the risk of any time-loss injury in the HC group relative to the IM group. The adjusted relative risk of a time-loss injury of any type was 46% higher in the HC men and 58% higher in the HC women compared to the IM men and women.

(c) Table 8 displays the results of the multivariate analysis showing the risk of time-loss overuse injury in the HC group relative to the IM group. The adjusted relative risk of injury was 55% higher in the HC men and 148% higher in the HC women, compared to the IM men and women.

(d) Table 9 displays the results of the multivariate analysis showing the risk of time-loss traumatic injury in the HC group relative to the IM group. The adjusted relative risk of injury was 51% higher in the HC men relative to the IM men. Although the adjusted relative risk of injury was 33% in the HC women relative to the IM women, this did not reach statistical significance.

Table 7. Cox Regression Results for Any Time-Loss Injury (Multivariate Analysis)

Variable	Level of Variable	Men			Women		
		Risk Ratio	95%CI[a]	p-value[b]	Risk Ratio	95%CI[a]	p-value[b]
Group	IM	1.00	----	----	1.00	----	----
	HC	1.46	1.21-1.76	<0.01	1.58	1.01-2.45	0.04
Rank	PV1	1.78	0.75-4.24	0.19			
	PV2	1.42	0.59-3.42	0.44			
	PFC	1.40	0.57-3.42	0.46			
	SPC	1.00	----	----			
MOS	63Y						
	63G						
	63W						
	63D						
	63H						
Race	Other	1.00	----	----	1.07	0.45-2.57	0.88
	Black	0.91	0.63-1.30	0.59	1.55	0.72-3.37	0.27
	White	0.82	0.61-1.12	0.22	3.26	1.23-8.59	0.02
	Hispanic	0.72	0.49-1.07	0.10	1.00	----	----
Basic Training Site	Ft Jackson	1.00	----	----	1.00	----	----
	Ft Knox	0.85	0.67-1.07	0.16	6.73	1.74-34.41	<0.01
	Ft LW[c]	0.84	0.55-1.31	0.45	1.17	0.67-2.05	0.58
	Ft Benning	0.80	0.56-1.14	0.22	----	----	----
	Ft Sill	1.02	0.67-1.56	0.93	0.77	0.38-1.56	0.47
	Other	0.50	0.23-1.12	0.09	3.67	0.82-16.44	0.09
Prior Injury	No	1.00	----	----	1.00	----	----
	Yes	2.02	1.57-2.59	<0.01	1.40	0.80-2.45	0.24
Prior Illness	No	1.00	----	----			
	Yes	1.10	0.66-1.83	0.73			
Cigarette Smoking	No	1.00	----	----	1.00	----	----
	Yes	1.41	1.18-1.69	<0.01	1.15	0.75-1.17	0.54
Smokeless Tobacco Use	No				1.00	----	----
	Yes				1.31	0.39-4.36	0.66
Push Up Quartile (Q)	Q1(few)	1.68	1.26-2.23	<0.01	1.47	0.78-2.78	0.24
	Q2	1.25	0.94-1.64	0.12	1.22	0.67-2.25	0.52
	Q3	1.13	0.85-1.49	0.41	0.60	0.30-1.20	0.15
	Q4(many)	1.00	----	----	1.00	----	----
Sit-Up Quartile (Q)	Q1(few)	1.42	1.07-1.88	0.02	1.10	0.58-2.09	0.78
	Q2	1.34	1.02-1.77	0.04	1.18	0.63-2.22	0.60
	Q3	1.33	1.00-1.75	0.05	1.19	0.64-2.21	0.59
	Q4(many)	1.00	----	----	1.00	----	----
2-Mile Run Quartile (Q)	Q1(slow)	1.91	1.47-2.49	<0.01	4.13	1.98-8.62	<0.01
	Q2	1.22	0.92-1.60	0.16	3.19	1.53-6.63	<0.01
	Q3	0.94	0.71-1.14	0.66	1.92	0.91-4.05	0.09
	Q4(fast)	1.00	----	----	1.00	----	----
Age Group	17-19yrs	1.00	----	----	1.00	----	----
	20-24yrs	1.06	0.88-1.28	0.53	0.98	0.62-1.58	0.96
	25-29yrs	1.11	0.78-1.59	0.55	1.59	0.84-3.00	0.16
	>29yrs	1.12	0.68-1.86	0.65	1.88	0.79-4.49	0.15

[a]CI=Confidence Interval
[b]p-value from Wald statistic
[c]LW=Leonard Wood

Table 8. Cox Regression Results for Time-Loss Overuse Injury (Multivariate Analysis)

Variable	Level of Variable	Men			Women		
		Risk Ratio	95%CI[a]	p-value[b]	Risk Ratio	95%CI[a]	p-value[b]
Group	IM	1.00	----	----	1.00	----	----
	HC	1.55	1.24-1.95	<0.01	2.48	1.47-4.19	<0.01
Rank	PV1	2.77	0.83-9.21	0.10			
	PV2	2.34	0.69-7.87	0.17			
	PFC	2.26	0.66-7.72	0.19			
	SPC	1.00	----	----			
MOS	63Y						
	63G						
	63W						
	63D						
	63H						
Race	Other	1.00	----	----	1.00	----	----
	Black	1.08	0.68-1.70	0.75	0.75	0.30-1.89	0.54
	White	0.99	0.67-1.46	0.97	1.09	0.50-2.39	0.83
	Hispanic	0.86	0.53-1.41	0.56	3.01	1.10-8.28	0.03
Basic Training Site	Ft Jackson	1.00	----	----	1.00	----	----
	Ft Knox	0.87	0.66-1.15	0.32	5.57	0.70-44.13	0.10
	Ft LW[c]	0.64	0.36-1.14	0.13	1.49	0.82-2.73	0.19
	Ft Benning	0.86	0.56-1.31	0.48	----	----	----
	Ft Sill	1.04	0.63-1.70	0.88	0.77	0.34-1.73	0.52
	Other	0.58	0.23-1.49	0.26	6.40	1.39-29.49	<0.01
Prior Injury	No	1.00	----	----	1.00	----	----
	Yes	1.90	1.41-2.56	<0.01	1.58	0.86-2.90	0.14
Prior Illness	No						
	Yes						
Cigarette Smoking	No	1.00	----	----	1.00	----	----
	Yes	1.39	1.12-1.73	<0.01	1.13	0.70-1.83	0.62
Smokeless Tobacco Use	No	1.00	----	----	1.00	----	----
	Yes	1.01	0.77-1.33	0.92	1.90	0.55-6.53	0.31
Push Up Quartile (Q)	Q1(few)	2.68	1.86-3.85	<0.01	1.78	0.86-3.66	0.12
	Q2	1.75	1.21-2.51	<0.01	1.18	0.58-2.40	0.65
	Q3	1.44	0.99-2.08	0.06	0.78	0.37-1.69	0.54
	Q4(many)	1.00	----	----	1.00	----	----
Sit-Up Quartile (Q)	Q1(few)	1.50	1.06-2.12	0.02	1.43	0.69-2.97	0.34
	Q2	1.33	0.94-1.89	0.11	1.46	0.70-3.02	0.31
	Q3	1.39	0.98-1.97	0.06	1.50	0.72-3.13	0.28
	Q4(many)	1.00	----	----	1.00	----	----
2-Mile Run Quartile (Q)	Q1(slow)	2.07	1.50-2.87	<0.01	4.57	1.94-10.78	<0.01
	Q2	1.32	0.94-1.85	0.11	2.89	1.21-6.91	0.02
	Q3	0.89	0.63-1.28	0.54	1.77	0.73-4.29	0.21
	Q4(fast)	1.00	----	----	1.00	----	----
Age Group	17-19yrs	1.00	----	----	1.00	----	----
	20-24yrs	1.17	0.94-1.45	0.17	0.85	0.50-1.45	0.54
	25-29yrs	1.24	0.82-1.88	0.30	1.31	0.65-2.68	0.45
	>29yrs	1.27	0.71-2.30	0.42	1.75	0.68-4.53	0.25

[a]CI=Confidence Interval
[b]p-value from Wald statistic
[c]LW=Leonard Wood

Table 9. Cox Regression Results for Time-Loss Traumatic Injury (Multivariate Analysis)

Variable	Level of Variable	Men			Women		
		Risk Ratio	95%CI[a]	p-value[b]	Risk Ratio	95%CI[a]	p-value[b]
Group	IM	1.00	----	----	1.00	----	----
	HC	1.51	1.07-2.14	0.02	1.33	0.59-2.87	0.48
Rank	PV1	0.91	0.26-3.16	0.88			
	PV2	0.68	0.19-2.44	0.55			
	PFC	0.79	0.22-2.90	0.72			
	SPC	1.00	----	----			
MOS	63Y	1.00	----	----			
	63G	1.45	0.64-3.26	0.37			
	63W	1.61	0.88-2.94	0.13			
	63D	1.70	0.75-3.93	0.20			
	63H	2.05	1.01-4.15	0.05			
Race	Other	1.00	----	----			
	Black	0.74	0.41-1.35	0.33			
	White	0.70	0.43-1.14	0.15			
	Hispanic	0.70	0.37-1.30	0.25			
Basic Training Site	Ft Jackson	1.00	----	----			
	Ft Knox	1.03	0.66-1.62	0.89			
	Ft LW[c]	1.44	0.68-3.03	0.34			
	Ft Benning	1.32	0.71-2.46	0.38			
	Ft Sill	1.33	0.61-2.89	0.47			
	Other	0.28	0.04-2.17	0.22			
Prior Injury	No	1.00	----	----			
	Yes	1.46	0.91-2.34	0.12			
Prior Illness	No						
	Yes						
Cigarette Smoking	No	1.00	----	----	1.00	----	----
	Yes	1.40	1.02-1.93	0.04	1.63	0.79-3.34	0.18
Smokeless Tobacco Use	No	1.00	----	----			
	Yes	0.84	0.52-1.35	0.48			
Push Up Quartile (Q)	Q1(few)	0.83	0.52-1.34	0.45	0.86	0.31-2.40	0.77
	Q2	0.78	0.50-1.22	0.28	0.87	0.34-2.26	0.78
	Q3	0.76	0.49-1.19	0.23	0.19	0.04-0.93	0.04
	Q4(many)	1.00	----	----	1.00	----	----
Sit-Up Quartile (Q)	Q1(few)	1.30	0.79-2.12	0.30	1.56	0.54-4.50	0.41
	Q2	1.41	0.89-2.22	0.15	1.31	0.45-3.87	0.62
	Q3	1.17	0.73-1.87	0.51	1.02	0.32-3.23	0.97
	Q4(many)	1.00	----	----	1.00	----	----
2-Mile Run Quartile (Q)	Q1(slow)	1.54	0.98-2.42	0.06	2.34	0.75-7.31	0.15
	Q2	1.09	0.69-1.73	0.72	1.54	0.46-5.15	0.48
	Q3	0.97	0.61-1.54	0.90	1.66	0.52-5.34	0.40
	Q4(fast)	1.00	----	----	1.00	----	----
Age Group	17-19yrs	1.00	----	----			
	20-24yrs	0.87	0.62-1.22	0.42			
	25-29yrs	1.35	0.76-2.39	0.30			
	>29yrs	0.68	0.24-1.95	0.48			

[a]CI=Confidence Interval
[b]p-value from Wald statistic
[c]LW=Leonard Wood

d. Fitness Outcomes. APFT data were considered only for soldiers that had complete data on the initial and first final APFT because some of the analyses (analysis of variance and analysis of covariance) required complete data.

(1) APFT Pass Rates. APFT pass rates were analyzed using the chi-square statistic comparing the proportion of soldiers passing and not passing in the two groups. Table 10 shows that more men in the HC group passed the initial test compared to men in the IM group. The IM and HC men did not differ on the proportion passing the first final test or passing after all final tests had been completed. For the women, there were no group differences on the initial test, first final test, or after all final tests were completed.

Table 10. Comparison of IM and HC Pass Incidence on APFTs

Group	Men			Women		
	Initial APFT	First Final APFT	All Final APFTs	Initial APFT	First Final APFT	All Final APFTs
IM (% passed)	66.7	80.7	99.6	60.5	74.4	98.7
HC (% passed)	72.0	83.7	99.0	57.0	75.5	97.3
p-value[a]	<0.01	0.24	0.19	0.64	0.92	0.48

[a]From chi square statistic comparing IM and HC Groups

(2) APFT Raw Scores.

(a) APFT raw scores were compared using ANOVA and, where necessary, ANCOVA. Analysis began with a one-way ANOVA comparing the two battalions on their initial APFT scores (gender-specific analysis on each APFT event). If there were no significant differences, a 2X2 (IM and HC groups X initial and first final test period) mixed model ANOVA was performed comparing the groups as independent measures and the test periods as repeated measures. If there were significant differences on the one-way ANOVA, an ANCOVA was performed. For the ANCOVA, adjustment was made for the differences in the initial score, and the two groups were compared on the first final test after adjustment.

(b) Table 11 shows the APFT results. For the men, there were significant differences on the initial test of push ups ($p<0.01$) and sit-ups ($p<0.01$) but not on the run ($p=0.69$). After adjustment for the initial differences using ANCOVA, there were no significant group differences on the first final test for push-ups ($p=0.74$) or sit-ups ($p=0.41$). On the 2-mile run, there was a significant main effect for test periods ($p<0.01$) but not for groups ($p=0.90$), and the probability value for the interaction was $p=0.07$.

(c) For the women (Table 11), there was a significant difference on the initial test of push-ups ($p<0.01$) but not on sit-ups ($p=0.22$) or the run ($p=0.88$). After adjustment for the initial differences using ANCOVA, there were no significant group differences on the first final test for push-ups ($p=0.20$). For sit-ups there was a significant main effect for test periods ($p<0.01$) but not for groups ($p=0.19$) and the interaction was not significant ($p=0.71$). On the 2-mile run, there was a significant difference for the test periods ($p<0.01$) but not for groups ($p=0.70$) and the interaction was not significant ($p=0.68$).

(d) In summary, these results indicate that APFT raw scores improved for both the IM and HC groups with few differences between groups for either men or women.

Table 11. APFT Raw Scores and Changes in Scores in the IM and HC Groups

Gender		Group	Push Ups (reps)		Sit-Ups (reps)		Two-Mile Run (min)	
			Mean	SD	Mean	SD	Mean	SD
Men	Initial Test	IM	50.3	11.7	60.8	10.0	14.9	1.4
		HC	53.8	12.5	62.5	10.4	14.9	1.5
	First Final Test	IM	53.5	11.3	64.8	9.9	14.7	1.4
		HC	56.3	12.6	65.8	10.3	14.6	1.3
	Change (%)	IM	6.3		6.6		1.3	
		HC	4.6		5.2		2.0	
Women	Initial Test	IM	28.6	9.4	59.9	10.6	18.4	2.2
		HC	33.4	11.6	61.7	12.0	18.3	2.0
	First Final Test	IM	32.1	9.4	64.2	9.4	17.9	1.5
		HC	37.3	12.6	66.4	12.0	17.8	2.0
	Change (%)	IM	12.2		7.2		2.7	
		HC	11.7		7.6		2.7	

(e) Improvements in APFT Raw Scores. Tables 12 (for IM group) and 13 (for HC group) show improvements in APFT scores for the 25% of individuals most fit and 25% of individuals least fit on arrival at APG. Percentile ranges (fitness category) were defined separately for each APFT event and gender. The greatest improvements in APFT scores were among individuals who were least fit on entry to AIT. The most fit individuals improved the least and, in some cases, actually lost fitness. For the least fit, improvements in scores ranged from 4.8% to 30.9% for the IM group and 5.3% to 34.3% for the HC group. For the most fit, the range of changes in scores were from –3.7 to 2.0% for the IM group and –0.8 to 3.6% for the HC group.

(f) Additional APFT Score Observations. Some additional observations on the APFT raw scores are included in Appendix E. These relate to initial fitness levels on arrival at APG (compared to the end of BCT) and the magnitude of the changes in APFT raw scores while in AIT.

Table 12. Changes in APFT Scores in the Most Fit and Least Fit for IM Group

Event	Group	Test or Change in Test Score	Men			Women		
			Mean	SD	p-value	Mean	SD	p-value
Push-Ups	Least Fit 25%	Initial	37.3	5.5	<0.01	19.4	3.5	<0.01
		First Final	44.0	7.2		25.4	5.6	
		Change (%)	18.0			30.9		
	Most Fit 25%	Initial	67.9	6.3	0.41	46.2	6.2	0.75
		First Final	67.2	9.9		47.0	8.6	
		Change (%)	1.0			1.7		
Sit-Ups	Least Fit 25%	Initial	50.2	5.0	<0.01	46.5	6.7	<0.01
		Final	57.3	6.4		56.5	4.5	
		Change (%)	14.1			21.5		
	Most Fit 25%	Initial	75.6	6.0	0.69	75.6	6.2	0.26
		Final	75.9	10.3		77.1	6.9	
		Change (%)	0.4			2.0		
2-Mile Run	Least Fit 25%	Initial	16.8	1.2	<0.01	21.2	2.4	<0.01
		First Final	16.0	1.7		19.0	1.2	
		Change (%)	4.8			10.4		
	Most Fit 25%	Initial	13.3	0.5	<0.01	16.1	0.7	<0.01
		First Final	13.6	0.8		16.7	1.2	
		Change (%)	-2.3[a]			-3.7[a]		

[a]Negative number indicates lower performance (slower run time) on final test

Table 13. Changes in APFT Scores in the Most Fit and Least Fit for HC Group

Event	Group		Men			Women		
			Mean	SD	p-value	Mean	SD	p-value
Push-Ups	Least Fit 25%	Initial	37.8	4.9	<0.01	17.8	6.0	<0.01
		First Final	44.2	8.2		23.9	8.8	
		Change (%)	16.9			34.3		
	Most Fit 25%	Initial	69.6	7.9	0.50	47.1	8.8	0.49
		First Final	69.3	10.2		48.1	11.2	
		Change (%)	- 0.4			2.1		
Sit-Ups	Least Fit 25%	Initial	50.0	5.2	<0.01	48.6	5.4	<0.01
		First Final	57.0	8.0		57.4	6.6	
		Change (%)	14.0			18.1		
	Most Fit 25%	Initial	75.9	6.0	0.17	75.8	7.6	0.02
		First Final	76.4	8.2		78.5	9.9	
		Change (%)	0.6			3.6		
2-Mile Run	Least Fit 25%	Initial	16.7	1.3	<0.01	20.7	1.4	<0.01
		First Final	15.7	1.2		19.6	2.0	
		Change (%)	6.0			5.3		
	Most Fit 25%	Initial	13.3	0.5	0.05	16.0	1.0	0.48
		First Final	13.4	1.0		15.9	1.3	
		Change (%)	-0.8[a]			-0.6[a]		

[a]Negative number indicates lower performance (slower run time) on final test

e. Six Item Physical Fitness Test (SIPFT).

(1) There were 43 men in the 143rd Ordnance (a portion of the IM cohort) and 19 men in the 16th Ordnance who volunteered for and completed all events of the SIPFT on Weeks 1 and 8 at APG (pretest and post-test, respectively). Only one woman in each battalion completed testing on all events, so their data is not shown. The SIPFT data were analyzed in the same manner as the APFT raw scores using ANOVA and ANCOVA. Where significant differences were found in initial test scores, a one-way ANOVA was used to check for improvements within groups (pretest vs. post-test).

(2) Table 14 shows a comparison of the mean scores of the IM and HC men. On the pretest, there were no significant differences between the groups on the power squat ($p=0.74$), heel hook ($p=0.97$), push-ups ($p=0.32$) or the 1-mile run ($p=0.75$). However, there were significant differences between groups on the standing long jump ($p<0.01$) and the shuttle run ($p=0.03$) with the 16th Ordnance demonstrating higher performance on both tests.

(3) On the standing long jump, both groups showed significant improvements in performance from the pretest to the posttest ($p<0.01$ for 143rd and $p=0.03$ for the 16th). After correcting for pretest differences with ANCOVA, there were no significant differences between groups ($p=0.48$). For the shuttle run, the 143rd showed a significant improvement in performance ($p<0.01$) but the 16th did not ($p=0.23$). After correcting for initial differences, the 143rd had significantly greater post-test performance than the 16th ($p<0.01$).

(4) For the power squat, there was a significant main effect for test period (pretest vs. post-test) ($p<0.01$) but not for battalion ($p=0.24$). There was a significant interaction ($p=0.01$), which indicated that the 143rd showed a greater improvement in performance than the 16th. For the heel hook, there was a significant main effect for test period ($p<0.01$) but not for group ($p=0.36$). There was a significant interaction ($p<0.01$), which indicated that the 143rd showed a greater improvement in performance than the 16th. For push-ups, there was a significant main effect for test period ($p<0.01$) but not for battalion ($p=0.31$) and the interaction was not significant ($p=0.99$). For the 1-mile run, there was a significant main effect for test period ($p<0.01$) but not for battalion ($p=0.87$) and the interaction was not significant ($p=0.71$).

(5) In summary, these results indicate that the 16th and 143rd showed similar improvements on the standing long jump, push-up, and 1-mile run. The 143rd showed greater improvement than the 16th on the power squat, heel hook, and shuttle run.

Table 14. Changes in Six Item Fitness Test Scores in the Two Groups (Values are Means±SD)

		Standing Long Jump (in)	Power Squat (reps)	Heel Hook (reps)	Shuttle Run (sec)	Push-Ups (reps)	1-Mile Run (min)
143rd (n=43)	Pretest	72.8±7.1	49.1±6.9	6.2±4.2	73.2±6.7	26.6±8.7	7.9±1.1
	Post-Test	80.6±7.4	55.0±6.3	9.3±5.2	65.9±3.9	33.1±10.3	7.5±1.1
	Change (%)	10.7	12.0	50.0	10.4	24.4	5.0
16th (n=19)	Pretest	79.5±11.0	49.7±7.0	6.1±6.2	69.5±4.5	24.1±9.7	7.8±0.9
	Post-Test	83.2±10.4	50.5±7.5	6.8±6.1	68.6±4.0	30.7±10.3	7.5±1.1
	Change (%)	4.7	1.6	11.5	1.3	27.4	3.8

f. Remedial Physical Training (RPT).

(1) There were 156 men and 29 women who participated in the RPT program during the time the injury control measures were in place. This represents 14% of the male IM cohort and 18% of female IM cohort. Table 15 shows the comparative APFT pass rates for IM soldiers in RPT and Non-RPT subgroups. It can easily be seen that soldiers in RPT were much less likely to pass the initial or first final APFT.

Table 15. APFT Pass Rates for Soldiers In and Not In RPT (IM Group Only)

	Men		Women	
	Initial APFT	First Final APFT	Initial APFT	First Final APFT
RPT (%pass)	24.8	47.4	20.8	51.6
Non-RPT (%pass)	72.5	86.3	65.4	79.2
p-value[a]	<0.01	<0.01	<0.01	<0.01

[a]From chi square statistic comparing RPT and Non-RPT groups

(2) Table 16 shows Cox regressions results for time to first injury comparing the RPT and Non-RPT subgroups within the IM group. For the men, the univariate analysis shows that the RPT group was much more likely to be injured than the Non-RPT group. For the women, the univariate analysis shows the injury risk was higher in RPT women compared to non-RPT women, but the difference was not statistically significant. The multivariate analysis in Table 15 looks at time to first injury while controlling for differences in APFT scores (APFT scores were entered as continuous variables). For the men, risk of injury is still higher in the RPT group even after controlling for fitness. For the women, injury risk is still higher in the RPT groups but this is not statistically significant.

Table 16. Cox Regression on Risk of First Injury in RPT Personnel vs. Non-RPT Personnel

Analysis	Variable	Men			Women		
		RR	95%CI	p-value	RR	95%CI	p-value
Univariate	RPT	2.14	1.64-2.80	<0.01	1.62	0.89-2.97	0.11
	No RPT	1.00	----	----	1.00	----	----
Multivariate	RPT	1.38	1.00-1.89	0.05	1.52	0.75-3.07	0.25
	No RPT	1.00	----	----	1.00	----	----
	Push-Ups	0.97	0.96-0.98	<0.01	0.94	0.90-0.99	0.01
	Sit-Ups	1.00	0.98-1.02	0.95	1.01	0.97-1.04	0.79
	2-Mile Run	1.28	1.19-1.39	<0.01	1.24	1.08-1.42	<0.01

7. DISCUSSION. This study investigated injury and fitness outcomes during implementation of a multiple intervention program that included modifications of the physical training program, cadre injury-reduction education, and use of a unit-based surveillance system. As a result of the injury education program, the command group instituted an Injury Control Advisory Committee (discussed below), which must be viewed as another intervention. When soldiers who went through the intervention program were compared to a previous period of time when soldiers did not, the total program was associated with a reduction in injury rates while improvements in APFT scores were similar. This suggests that this multiple intervention program was successful in reducing injuries while maintaining necessary improvements in physical fitness. Since this program involved a number of interventions, it is not possible to determine the intervention that was most effective in reducing injuries. The multiple strategies may have been effective because different individuals responded to different aspects of the program.

a. Educational Program.

(1) It has been shown that alone, educational efforts directed at injury reduction have only very limited success (15, 18, 19, 30, 77, 91). On the other hand, what has been termed "community-based approaches" (42) have shown more promise in reducing injuries. Community-based approaches combine aspects of educational efforts with focused community leadership participation, multi-agency collaboration, tailoring to the needs of the local community, modification of attitudes, behaviors and norms, and alterations in the physical environment. In this approach, public health personnel work within the community and consider perceived needs, use local knowledge and expertise, and encourage community ownership of the problem (16, 17, 57, 83, 93-95). The injury control program used in our project had many of these elements including an educational program, strong initial support from the command group and NCOs, collaboration between agencies (143rd Ordnance Battalion, KAHC, USAPFS, and the USACHPPM), and alterations in the physical training program.

(2) NCOs gave the one-day educational program strong approval ratings. Conversations with NCOs indicated that they felt they could control injuries within their units at the conclusion of the training. Further, the week-long training on how to conduct PRT convinced NCO's that they could successfully conduct the new physical training program and that training was demanding enough to allow soldiers to pass the APFT. Trainers from the USAPFS were strong motivators who considered NCO comments and made immediate adjustments in the program based on these comments. Where changes could not be made, USAPFS trainers provided the rationale.

b. Injury Control Advisory Committee (ICAC).

(1) The command group of the 143rd Ordnance Battalion instituted an ICAC as a result of the recommendations made during the educational program. The ICAC was used as the capstone exercise in the fifth training module and was suggested as a forum to manage unit injuries. There are no studies indicating that such a committee can reduce the incidence of injuries. However, systematic examination of data and discussion of injury prevention priorities would appear to make sense if the information gained from such sessions is applied and enforced. One previous investigation examined the use of an ICAC in medic AIT but did not report on injury or fitness outcome measures (82).

(2) The ICAC in the 143rd Ordnance Battalion was comprised of all three training company commanders, their senior drill sergeants, and an injury subject matter expert from the local medical department. This committee met monthly for about 1 hour from September 2001 through March 2002 for a total of seven times. The primary purpose of the committee was to advise the battalion commander on interventions thought to reduce injuries. Company commanders and drill sergeants attended the first two meetings while the remainder of the meetings included the battalion commander.

(3) The intent of the committee was to review each company's surveillance reports, discuss possible strategies to reduce injuries, and to monitor the effectiveness of changes. In reality, this committee recommended very few changes. Changes in physical training were discussed, but since the physical training was prescriptive they were not permitted to modify the program during the study period. Moreover, it took many months for the committee members to learn how to effectively participate in the meetings. The committee used this opportunity to learn the process of applying the principles of risk management to musculoskeletal injuries, to understand and compare the practical value of the statistical injury reports, to evaluate the process of the Battalion Surveillance System, and to discuss eventual changes to the physical training once the study period was concluded. The injury subject matter expert assisted with surveillance report interpretation, teaching leaders how to problem-solve plausible causes of injury, and how to observe the battalion physical readiness

training program. In short, the committee utilized most of the meeting time sharing reports and spent less time discussing trends and solutions. Thus, it is not clear how much the committee might have contributed to the reduction in injury rates.

c. Physical Training.

(1) As noted above, the injury control program initially had strong command and noncommissioned office (NCO) support. However, that support seemed to shift during the course of the program. Command support remained high but NCO support eroded, presumably for several reasons. After several months in the program, NCOs felt confined by the prescriptive nature of the PRT program and wanted the flexibility to perform other types of physical training. This was not allowed because of the strict conditions needed to test the PRT program's effectiveness. The perceived lack of control led to some consternation on the part of the NCOs because they felt their training prerogatives had been overridden. Also, the daily monitoring of the program led to several reports of program deviations. As preplanned, this was reported to the S-3 who reported to the company commanders. These reports could have caused further disquiet on the part of the NCOs. In this portion of the study, we deviated from the community-based approach mentioned earlier.

(2) Additional concerns arose with the PRT program when seemingly larger than normal groups of soldiers began to fail the diagnostic and first final APFT. At the time, these failures were assumed to be a failure of the PRT program and RPT was mandated by the brigade commander to correct this. In retrospect, it can now been seen that IM soldiers were less fit on entry into to APG compared to their HC counterparts. This was indicated by the fact that the initial APFT pass rate for male IM soldiers was less than that for HC soldiers (Table 10). It is reasonable to assume that IM soldiers would have more difficulty improving their fitness and passing the diagnostic and first final test because of this lower level of initial fitness.

(3) The initiation of RPT makes it difficult to determine the effects of PRT alone on fitness, since the least fit individuals in the IM group were given additional physical training. One way of comparing the physical training programs in the HC and IM groups is to assume that both had some form of "remedial training" (RPT for the IM group and SIF for the HC group). The IM men had a lower initial APFT pass rate when compared to the HC men. However, the first final APFT pass rates and ultimate APFT pass rates did not differ between the two groups (Table 10). From this perspective, the PRT program, in the presence of remedial programs, can be viewed as resulting in larger improvements in APFT pass rates. We conducted a previous study in BCT that compared a battalion using PRT to a battalion using traditional BCT physical training without a remedial program. Initial APFT pass rates were the same for both battalions. At the end of the training cycle, the battalion using PRT had

higher pass rates on the final APFT and a higher pass rate after all retakes had been completed (53, 54).

(4) Male soldiers in RPT had a higher injury risk and injury risk tended to be higher among the women. Since soldiers in RPT were there because of their low physical fitness, this is in consonance with past studies that show that low physical fitness is associated with higher injury rates in BCT (31, 35, 36, 50, 62, 63, 75, 97) and among soldiers in operational Army units (45, 78, 79). However, even after APFT scores were controlled for in a multivariate analysis in the present study, male soldiers in the RPT group still had higher injury risk than those who did not participate in RPT (Table 16). It is possible that the additional physical training performed by this group contributed to their injury rates. It has been shown that individuals who perform greater amounts of running are more likely to be injured (34, 37, 64, 65, 69, 87, 96). It is possible that additional exposure to forms of exercise other than running (e.g., calisthenics, push-up/sit-up improvement) may also increase injury risk.

(5) Certain features of the PRT training program that have been previously shown to reduce injuries or are suspected of reducing injuries may account for a portion of the reduction in injury rates. One of these features was the gradual introduction of the exercises following the principle of progressive overload (70). When we observed physical training in the HC group, we noted that soldiers newly arrived from BCT were introduced to physical training without any exercise progression. That is, they performed whatever training the company had planned that day without the gradual introduction of exercise stress. As discussed in Appendix E, fitness levels of the soldiers arriving at APG were similar to recruits just completing BCT. However, our published and unpublished observations in BCT (47, 50, 53, 62, 63) suggest that soldiers often performed little physical training in the 2 to 3 weeks prior to arrival at their AIT units. Thus, although soldiers appear to retain fitness (possibly because of what physical activity they do perform in the final weeks of BCT), their recent physical activity may have declined and a short period of exercise "ramp-up" on arrival in AIT may be appropriate. Soldiers in the IM program were provided a single week that allowed them to learn and gradually adapt to the new PRT exercises and this may have played a role in the lower IM injury rates. A previous investigation in Combat Medic AIT training showed that the gradual, progressive introduction of running resulted in fewer profiles and fewer clinic visits (80).

(6) Another feature of the program that may have assisted in reducing injuries was the lower running mileage. In the present study, our observations on the HC group suggest they averaged 7.1 miles/wk of long-slow sustained running plus about 1 day/wk of interval training (no mileage was obtained on the latter). The IM group performed no more than 2 miles of long-slow sustained running per week. With regard to the interval training for the IM group, we do not know how far individual soldiers ran. However, if the assumption is made that the average soldier completed 200 yards per 30 second

run and that 8 repeats were performed, then 1600 yards or 0.91 miles of running were completed each session. Since 1.6 interval sessions were completed each week, the average interval mileage was 1.5 miles/wk. If the long distance and interval runs are added together, the average running distance may have been about 3.5 miles/wk for the IM group. This analysis suggests the IM group may have performed less than ½ the mileage of the HC group. As noted above, past studies have strongly suggested that as the total amount of running increases, the incidence of injuries increases (37, 64, 65, 69, 76, 87, 96) with little effect on improvements in aerobic fitness (37, 87, 96). Other studies (53, 54, 74, 84) suggest that substituting interval training for distance running may also reduce BCT injury rates, but these studies were confounded with multiple interventions making it difficult to determine the effectiveness of interval training alone. Interval training may play a key role in the PRT program since intervals have been shown to result in greater improvements in running speed than long-slow sustained running alone, especially in sedentary and recreationally active individuals (67). In our past study of PRT in BCT we demonstrated a reduction in injuries in association with a reduction in running mileage and introduction of interval training (53, 54).

(7) Another program feature that may have been associated with the lower IC injury rates may have been the ability group runs. We observed that during HC runs, the entire training group ran together. Some individuals would frequently fall out and run-walk to catch up with the larger group. The ability group runs performed by the IC group allowed less aerobically fit individuals to run at speeds more appropriate to their lower aerobic capacity. These lower running speeds may have allowed them to avoid excessive fatigue that can result in gait changes (9, 20, 68, 72) and possibly increase injury risk. Further, the slower running speeds may have allowed them to continue running for longer periods of time allowing more improvement in aerobic capacity. Despite the lower total running mileage, ability group running, combined with intervals, appears to have been as successful as running in larger groups since the improvements in running speed were similar in the two cohorts.

(8) A final physical training-related factor that may partially account for the lower overuse injury incidence in the IM group was the variety of exercises in the program. There are no studies indicating that a greater variety of exercise will reduce injuries, but sports medicine professionals often recommend "cross-training" for this purpose (90). The cross-training concept simply involves alternating different types of exercises on different days. Exercises are "different" in the sense that they involve different energy systems (i.e., different fitness components like aerobic or muscle strength) (70) or different body parts. Reducing the repetitive use of particular energy systems or different body parts may allow more time for recovery and reduce the probability of overuse injuries. The PRT program involved calisthentic and movement drills in every session but used alternate days for the other types of exercises.

(9) As noted above, our past study of PRT in BCT which featured progressive overload, a reduction in running mileage, interval training, and a variety of exercises showed lower injury rates (53, 54). A cohort of women from this study was followed into Combat Medic AIT. Only three men in the study went to Combat Medic AIT so this group was not analyzed. In AIT, the PRT women performed traditional physical training. It was found that these PRT women had lower initial injury rates and fewer sick call visits at the start of AIT when they were compared to non-PRT women (i.e., women who were not involved in the BCT PRT program). PRT women had injury rates that were similar to non-PRT women at the completion of the 10-week AIT course as would be expected since both groups were going through the same training and were exposed to the same risks. Initial APFT pass rates were similar for the two groups but by the end of training, the PRT women surpassed the non-PRT women (81). Final pass rates may have been higher for the PRT women because PRT women had more time to train and less time on profile

d. Injury Surveillance.

(1) The major purposes of injury surveillance are to assess health status, conduct research, determine public health priorities, and evaluate programs (92). The Clinic Surveillance System at APG was developed and used for the latter two purposes. The injury problem was brought to the attention of the brigade commander by demonstrating rates and activities associated with injuries. Since running and sports seemed to be the major activities associated with injuries, emphasis was placed on modifications to the physical training program that were based on successful past interventions (53, 54, 80). The surveillance system was then used to evaluate the effectiveness of the PRT program and the other interventions. This Clinic Surveillance System was in use during both the HC and IM periods. It was a "passive system" from the perspective of the command group in that the information was regularly provided to them without the requirement for action on their part. Since this system was in place during both HC and IM periods, it cannot be considered an intervention.

(2) On the other hand, the Battalion Surveillance System was provided to company level training personnel when the IM portion of the study began. This system required training personnel to actively enter data from the soldiers "sick-call slips" when they returned from the Troop Medical Clinic. Training personnel could print out a wide variety of reports for any time period desired and at any time they wanted them. A number of these reports were used during the Injury Control Advisory Committee sessions and this may have alerted unit leadership to injury problems. The three training company commanders generated most of these reports monthly. A portion of the report could be used daily by the drill sergeants to manage profiled soldiers. Commanders could evaluate his or her company reports against their printed physical training schedule. We did not systematically monitor each company's compliance with entering all soldiers who presented at sick call into the company sick call

database. However, each company commander was required to display his unit's injury statistics for the previous month to the battalion commander. Furthermore, it was to the company commander's advantage to be compliant in order for their drill sergeants to properly track and manage those soldiers who were on profile and monitor their progress.

e. Six-Item Physical Fitness Test (SIPFT).

(1) Performance improvements on the SIPFT were generally greater for soldiers in the 143rd Ordnance Battalion (IM subjects) when compared to soldiers in the 16th Ordnance Battalion. The 143rd Ordnance soldiers improved significantly more on the heel hook, shuttle run, and power squat. This should not be surprising because of the physical training performed by the 143rd Ordnance. The heel hook was a climbing drill exercise and other climbing drills (pull-up, chin-up, curl-up) exercised muscle groups involved in the heel hook. Soldiers performed sprint-type exercises both during the 30/90 runs and during the guerilla drills and these exercises may have assisted in improving shuttle run performance. The power squat was a calisthenic exercise and other calisthenic exercises recruited muscle groups used during the power squat test (e.g., bend and reach, high jumper, squat stepper).

(2) Thus, soldiers performed specific exercises involved in the SIFPT and exercised muscle groups involved in these tasks. Previous studies have shown that exercise on specific muscle strength/endurance task will result in the greatest improvement on that task (5, 22-26, 43, 61, 71, 85, 89). Exercises that improve the muscular strength, muscular endurance, or cardiorespiratory endurance of muscle groups involved in a test can also improve test performance (29, 51, 61, 85, 88).

f. Limitations.

(1) This study used a historical control group. Historical controls can be influenced by temporal changes that are not apparent or cannot be readily identified because they occurred in the past and were not monitored at the time. For example, in the HC portion of the study, changes in training cadre could have influenced safety procedures used during training in the shop areas where soldiers trained for their MOS. Physical training procedures may have changed over time in the HC group. The 3 weeks of physical training observations we performed may not have been representative of the physical training performed during the entire HC period. A number of different medical care providers were in the clinic during the study period and they may have had different criteria for assigning profiles.

(2) RPT was not originally planned for the study and was not instituted until the study was about 40% complete. However, the SIF program was part of training during the HC period. The introduction of RPT may have

made physical training more similar for the IM and HC groups but it was not present during the entire IM group study period.

(3) The fact that multiple interventions were examined in this study makes it difficult to determine which interventions were most effective in reducing injuries. Applying the literature suggests the PRT program may be most effective in this regard. It is not clear how the educational program, the Injury Control Advisory Committee, or the Battalion Surveillance System influenced injury risk.

8. SUMMARY AND CONCLUSIONS. The multiple intervention program used in this investigation included the introduction of PRT, cadre injury-reduction education, and use of a unit level surveillance system. Training cadre also instituted an ICAC. Injury and fitness outcomes were compared between two groups of Ordnance AIT soldiers, those who were present while the interventions were in place and those who were present prior to the interventions. We found that soldiers who were present during the interventions had lower injury risk and similar improvements in physical fitness when compared to soldiers who were present prior to the interventions. Potential confounders include known and unknown temporal changes, which are inherent to any historical cohort design, and the introduction of RPT near the middle of the intervention period. Results suggest that this multiple intervention program was successful in reducing injuries while maintaining necessary improvements in physical fitness. However, since this program involved numerous interventions, it is not possible to determine the single intervention that was most effective in reducing injuries.

APPENDIX A
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APPENDIX B

143rd ORDNANCE BATTALION SICK CALL SLIP

❑ Initial Visit ❑ Follow-up or Treatment Visit

Name (Last, First, MI): _____ Rank: _____

SSN: _____ **Organization:** _____ **Date:** _____

Unit Command Remarks:

Problem existed prior to AIT?
❑ Yes ❑ No
Injured performing official duties?
❑ Yes ❑ No

MEDICAL OFFICER SECTION: Check ONLY ONE in each section below (select MOST LIMITING if soldier has multiple complaints)

Body Part Affected:

- ❑ Abdomen
- ❑ Ankle
- ❑ Arm
- ❑ Back
- ❑ Buttocks
- ❑ Chest/Ribs
- ❑ Elbow
- ❑ Foot/Toe
- ❑ Forearm
- ❑ Hand/Fingers
- ❑ Head/Face
- ❑ Hip/Pelvis/Groin
- ❑ Knee
- ❑ Leg
- ❑ Neck
- ❑ Shoulder
- ❑ Thigh/Hamstring
- ❑ Wrist
- ❑ Other*

***Explain:**

Complaint/Diagnosis:

- ❑ Abrasion/Cut/Bruise
- ❑ Bite/Sting
- ❑ Blister
- ❑ Cold Injury
- ❑ Fracture/Dislocation
- ❑ Heat Injury
- ❑ Illness
- ❑ Normal Exam
- ❑ Pain/Sprain/Strain/'itis'
- ❑ Personal
- ❑ Stress fracture
- ❑ Other*

***Explain:**

Cause/Associated Activity:

- ❑ Environmental
- ❑ Fighting-anger
- ❑ Illness
- ❑ Marching
- ❑ Running – Distance
- ❑ Running – Sprints
- ❑ PRT – Other (not running)
- ❑ Slip/Trip/Fall (not during PRT)
- ❑ Sports
- ❑ Work/MOS/Task Related
- ❑ Other*

***Explain:**

Type of Injury:

- ❑ Overuse
- ❑ Acute
- ❑ Not applicable

Profile Status:

- ❑ RTD
- ❑ Temporary

Start date: Today
End date: _____

- ❑ Permanent
- ❑ Hospital
- ❑ Not Examined
- ❑ Other*

***Explain:**

Limitations (up to 3 max):

- ❑ No back flex/ext/rot
- ❑ No deep LE bending
- ❑ No Guerilla drills
- ❑ No Kevlar
- ❑ No lifting/carrying over 20 lbs
- ❑ No pull-ups
- ❑ No PRT (MUST explain in remarks)
- ❑ No run/jump/march
- ❑ No UE dumbbells
- ❑ No UE weight bearing
- ❑ PRT@OPD (explain in remarks)
- ❑ Quarters
- ❑ Shaving profile
- ❑ Soft Shoe Only

Remarks:

SIGNATURE OF MEDICAL OFFICER

Please contact this medical officer at the Troop Medical Clinic (5-3001/3726) if form is incomplete.

Appendix C

Soldier Health Inprocessing Questionnaire

58295

Soldier Health Inprocessing Sheet, revised 7Jun01

ALL SOLDIERS FILL OUT THE FOLLOWING

1. Today's Date (DD-MM-YY) ☐☐ - ☐☐ - ☐☐ 2. SSN ☐☐☐ - ☐☐ - ☐☐☐☐

3. Last Name ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

4. First Name ☐☐☐☐☐☐☐☐☐☐☐☐☐☐ 5. Grade E☐ or O☐ (E = Enlisted, O = Officer)

6. Race

☐ Asian American ☐ Hispanic American

☐ African American ☐ Native American

☐ Caucasian American ☐ Other American

7. Gender

☐ Male ☐ Female

8. Date of Birth (DD-MM-YY) ☐☐ - ☐☐ - ☐☐ 9. Age ☐☐

10. Unit Assigned to:

☐ A (16th) ☐ B (16th) ☐ C (16th) ☐ D (16th) ☐ E (16th) ☐ A (143rd) ☐ B (143rd) ☐ C (143rd)

11. Basic Training Site:

☐ Ft. Jackson ☐ Ft. Knox ☐ Ft. Leonard Wood ☐ Ft. Benning ☐ Ft. Sill ☐ Other ☐☐☐☐☐☐☐☐

12. Do you presently have an injury that would adversely affect your performance during AIT?

☐ Yes ☐ No

13. Do you presently have an illness that would adversely affect your performance during AIT? ☐ Yes ☐ No

14. If your answer to Question #12 or #13 is Yes, what area of the body does the injury or illness affect?

☐ General Health ☐ Arm ☐ Lower Back ☐ Ankle

☐ Eyes ☐ Hand ☐ Hip and Upper Leg ☐ Foot

☐ Head ☐ Neck and Upper Back ☐ Knee ☐ Other ☐☐☐☐☐☐☐☐☐

☐ Shoulder ☐ Chest ☐ Lower Leg

15. When were you injured?

☐ Prior to BCT ☐ During BCT ☐ After BCT

16. When did your illness begin?

☐ Prior to BCT ☐ During BCT ☐ After BCT

17. In the space provided, tell us why you may need to see the doctor:

_____

18. Did you smoke 1 or more cigarettes in the 30 days before Basic Training? ☐ Yes ☐ No

19. Did you smoke on 20 or more days in the 30 days before Basic Training? ☐ Yes ☐ No

If yes, how many cigarettes? ☐ 10 or fewer cigarettes per day on average

☐ 10-20 cigarettes per day on average

☐ 20 or more cigarettes per day on average

20. Did you use smokeless tobacco (chewing, snuffing, pinching, etc.) at least once in the 30 days before Basic Training? ☐ Yes ☐ No

21. Did you use smokeless tobacco (chewing, snuffing, pinching, etc.) on 20 or more days in the 30 days before Basic Training? ☐ Yes ☐ No

If yes, how much? ☐ Less than 1 can, pouch, or plug per day on average

☐ 1 can, pouch, or plug per day on average

☐ 2 or more cans, pouches, or plugs per day on average

FEMALES ONLY:

22. Have you had a PAP smear in the last year? ☐ Yes ☐ No

If yes, were the results abnormal? ☐ Yes ☐ No

Appendix D

Injury Data Collection Sheet

Draft

Injury Sheet

revised June 2001

Social Security Number ☐☐☐ - ☐☐ - ☐☐☐☐

Last Name ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Today's date (DD/MM/YY) ☐☐ - ☐☐ - ☐☐

Gender:
☐ Male ☐ Female

Unit:
☐ A (16th) ☐ B (16th) ☐ C (16th) ☐ D (16th) ☐ E (16th) ☐ A (143rd) ☐ B (143rd) ☐ C (143rd)
☐ Permanent Party ☐ USMC ☐ USAF ☐ ANCOC ☐ BNCOC ☐ Other

1. Cause Codes (check one)

☐ Sports
☐ Running
☐ PT (other than running)
☐ Road March
☐ Environmental (heat,cold)
☐ Fall
☐ Work Related
☐ Fighting, anger-related
☐ Other ☐☐☐☐☐☐☐☐☐☐
☐ Unknown

2. Location (check one)

☐ Left
☐ Right
☐ Bilateral
☐ Other
☐ Unknown

3. Body Part (check one)

☐ Unknown
☐ Other

Head
☐ Ear
☐ Eye
☐ Nose
☐ Neck
☐ Face, NOS
☐ Head, NOS

Shoulder
☐ Clavicle
☐ Shoulder, NOS

Arm
☐ Arm, NOS

Elbow
☐ Elbow, NOS

Forearm
☐ Wrist
☐ Forearm, NOS

Hand
☐ Metacarpal
☐ Finger, NOS
☐ Hand, NOS

Hip
☐ Gr. trochanter
☐ Femoral neck
☐ Hip, NOS

Leg (Upper)
☐ Quadriceps
☐ Hamstring
☐ Femur
☐ Upper leg, NOS

Leg (Lower)
☐ Tibia
☐ Fibula
☐ Gastrocnemius muscle
☐ Lower leg, NOS

Knee
☐ Medial collateral ligament
☐ Lateral collateral ligament
☐ Anterior cruciate ligament
☐ Posterior cruciate ligament
☐ IT Band
☐ Medial meniscus
☐ Lateral meniscus
☐ Other meniscus
☐ Patella
☐ Patella tendon
☐ Patellofemoral joint
☐ Tibial plateau
☐ Knee, NOS

Ankle
☐ Achilles
☐ Lateral ligament
☐ Medial ligaments
☐ Ankle, NOS

Foot
☐ Metatarsal
☐ Pes planus
☐ Pes cavus
☐ Plantar fascia
☐ Sesmoid
☐ Toe, NOS
☐ Foot, NOS

Back & Spine
☐ C-spine area
☐ T-spine area
☐ L-spine area
☐ Back or spine, NOS

Rib
☐ Rib, NOS

4. Injury Category (check one)

☐ Overuse
☐ Traumatic
☐ Other
☐ Unknown

5.Type of Injury (check one)

☐ Normal exam
☐ Abrasion/Laceration
☐ Arthritis
☐ Bursitis
☐ Contusion
☐ Dislocation
☐ Fasciitis
☐ Fracture
☐ Ingrown toenail
☐ Instability
☐ Muscle spasm
☐ Neuropathy
☐ Osteochondral defect
☐ Pain
☐ Radiculopathy/Radiculitis
☐ Rupture
☐ Shin splints
☐ Strain
☐ Spondylosis
☐ Sprain
☐ Stress fracture
☐ Stress reaction
☐ Synovitis
☐ Subluxation
☐ Tendinitis
☐ Tear
☐ Other ☐☐☐☐☐☐☐☐☐☐
☐ Unknown

6. Type of Visit (check one)

☐ Initial Visit For This Injury
☐ Follow Up Visit For This Injury

7. Disposition (check one)

☐ No profile
☐ Profile
☐ Quarters
☐ Hospitalized
☐ Other
☐ Unknown

8. Number of Profile or Quarters Days

☐☐ DAYS

☐ EPTS (recommended)
☐ MEB

9. Consultation (check one)

☐ None
☐ Orthopedics
☐ Podiatry
☐ Physical Therapy
☐ Gen surgery (cast clinic)
☐ Other

Record only *one* injury (the most serious).

APPENDIX E

Observations on Changes in APFT Scores

This is the first study that has reported on changes in APFT scores among AIT students. As such, we made some additional observations that may be of interest.

It has been anecdotally suggested that soldiers lose some fitness in the transition from BCT to AIT. This is because there is generally a period of time (2 to 3 weeks) when recruits perform little organized physical training. Recruits take their final APFT in the seventh week of BCT then perform a field training exercise (FTX). On the FXT no physical training is performed but recruits are very physically active and this may assist in maintaining fitness. When they return from the FTX, activities involve administrative outprocessing and preparation for BCT graduation. One study showed only two to four training sessions were carried out in the last 2 weeks of training (53). After graduation, soldiers travel to their AIT sites and are involved with administrative inprocessing. Soldiers may have a short period of time before they begin physical training at their AIT site.

To examine fitness levels at the end of BCT and those on arrival at the Ordnance School we examined past BCT studies and compared them to the first APFT given at the Ordnance School. Table E-1, shows that soldiers on entry to the Ordnance School had APFT scores similar to those seen at the conclusion of BCT (53, 62). Thus, it would seem that, on average, soldiers retained their BCT exit level of fitness.

One limitation to this comparison may be that the previous investigations examined only APFT scores at Fort Jackson while in the present study soldiers come from many BCT sites (see Table 1). However, all soldiers must meet the same APFT criteria to graduate from BCT regardless of their BCT site.

Table E-1. Comparison of APFT Scores at the End of BCT with Initial APFT In This Study

		Reference 53	Reference 53[a]	Reference 62[b]	Present Study[d]	
					IM Group	HC Group
Men	Push-Ups (reps)	52±13	50±13	47±13	50±12	54±13
	Sit-Ups (reps)	60±14	63±11	57±10	61±10	63±10
	2-Mile Run (min)	14.8±1.3	14.6±1.3	14.6±1.6	14.9±1.4	14.9±1.5
Women	Push-Ups (reps)	32±17	26±10	25±10	29±9	33±12
	Sit-Ups (reps)	53±18	59±11	54±12	60±11	62±12
	2-Mile Run (min)	18.2±1.7	18.0±1.7	17.8±1.6	18.4±2.2	18.3±2.0

[a]Control Group of referenced study
[b]Master Tracking System data from referenced study

A second observation was that changes in APFT raw scores in AIT are relatively small compared to changes in BCT as shown in Table E-2. Many BCT recruits come in at very low levels of fitness (53, 55, 62) so relative fitness gains must be large to allow them to pass the APFT. In BCT, "passing" each APFT event requires 50 points (on an age and gender adjusted 100-point scale), while 60 points are required during AIT and for the rest of a soldier's military career (3). The 50-point level is approximately the 3rd to 5th percentile (depending on age, gender, and APFT event) for active duty soldiers; the 60-point level is specifically set at the 8th percentile for active duty soldiers (Personnel Communication, Dr Louis Tomasi, US Army Physical Fitness School, Fort Benning, Georgia). A soldier graduating from BCT at the 50-point level does not have to increase fitness much to pass at the 60-point level. To obtain 50 points, a 17-21 year old man would have to complete 35 push-ups, 47 sit-ups, and complete the run in 16.6 minutes. To obtain 60 points, a 17-21 year old man would have to complete 42 push-ups, 53 sit-ups, and complete the run in 15.9 minutes. Most soldiers can pass the APFT at the 60 point level at the conclusion of BCT. The largest improvements seen in AIT are in the lowest fit individuals (Tables 12 and 13) who must come up from lower fitness to reach the passing 60-point level.

Table E-2. Changes in APFT Scores in BCT and Ordnance AIT

Study	APFT Event	Men		Women	
		Absolute Change (reps or min)	Relative Change (%)	Absolute Change (reps or min)	Relative Change (%)
Reference 53	Push-Ups	15	47	15	139
	Sit-Ups	16	39	20	57
	2-Mile Run	-2.9	17	-3.7	17
Reference 53	Push-Ups	19	58	21	206
	Sit-Ups	17	40	18	53
	2-Mile Run	-2.2	13	-2.9	14
Present Study IM Group	Push-Ups	3	6	4	12
	Sit-Ups	4	7	4	7
	2-Mile Run	-0.2	1	-0.5	3
Present Study HC Group	Push-Ups	3	5	4	12
	Sit-Ups	3	5	5	8
	2-Mile Run	-0.3	2	-0.5	3

Appendix F

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